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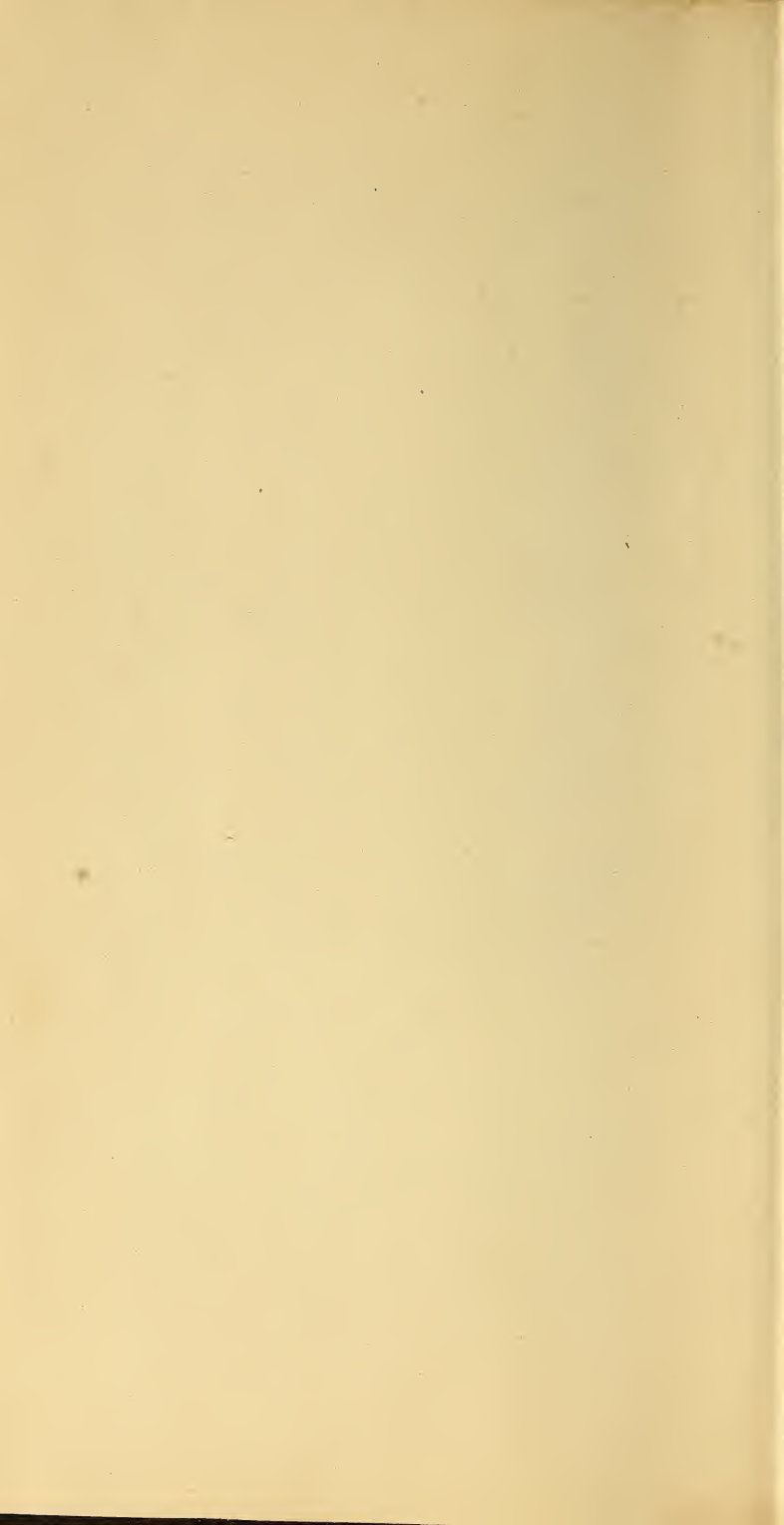


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COMPANION

TO

305

CLASS-BOOK OF PHYSIOLOGY;

DESIGNED AS AN

AID TO THE TEACHER IN HIS RECITATIONS AND REVIEWS.

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CHEMISTRY, AND NATURAL HISTORY, IN THE CON-
NECTICUT STATE NORMAL SCHOOL.

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P R E F A C E.

THE following pages have been compiled at the suggestion of Professor Jenks, Principal of Pierce Academy, Mass., and are designed to aid teachers in conducting recitations in the Class-Book of Physiology.

Professor Jenks has made thorough trial of this method of conducting recitations in other departments of science, and has found it eminently successful. The manner of using the Companion, and the advantages of this mode of study, will be found over his own signature in the Introduction.

As Professor Jenks has no personal interest in the Companion, except in common with other teachers who may use it, he is entitled to the thanks of the author, and of all who may hereafter be aided in their labors by his voluntary suggestions.

B. N. COMINGS.

NEW BRITAIN, *May*, 1854.

INTRODUCTION.

SUGGESTIONS as to the best method of conducting recitations in the Class-Book of Physiology, by the aid of the Companion :

1st. Let it be considered in what time the circumstances of the school will require the class to complete the book, or any definite part of it, and make the advance lesson of sufficient length to accomplish the object in the given time.

2d. Let the *previous* lesson be a constant review.

3d. After a certain number of recitations, which may be determined by the teacher, according to the maturity of the class, commence a re-review of all the portions gone over.

4th. Let the pupil be required, in his first examination of the advance lesson, to peruse carefully every portion of the text without regard to the questions at the bottom of the page.

5th. "Companion" in hand, let the pupil recite the lesson, and illustrate all the diagrams, *without a word from the teacher*, and with eyes upon the question, or topical suggestions, after the style of repeating a story to a friend, instead of having the questions *asked* by the teacher, or even asking them himself. Further illustration may be drawn from the pupil at the close of his portion of the recitation, according to the skill and discretion of the teacher.

6th. Let the teacher carefully avoid all appearance of *routine* in calling upon the several pupils, that, by only naming the scholar to recite, without hinting where the last pupil closed *his* recitation, the most undivided attention will be elicited, of necessity, from every member of the class.

7th. To avoid the liability, even in the slightest degree, of localizing too much by such constant *eye* reference on the part of the pupil, let the teacher hear the re-reviews occasionally, by suggesting the topics himself, or by calling only for the illustration of the diagrams.

8th. At the examination, let the names of the pupils be put into a vase, on separate slips of paper, and drawn out as a topic is called for by one of the audience or examining committee, or teacher himself—the pupil with the “Companion” in hand, proceeding at once to present as in a continued narrative, his knowledge of the subject.

9th. Where apparatus or specimens are used in illustration, let the advance lesson always be illustrated the day previous, that the pupil may at once commence the investigation of the lesson understandingly, he not being expected to make new discoveries in the science by the bent of his own genius, but only (while a pupil) to acquaint himself with the discoveries of others.

ADVANTAGES OF THIS MODE OF STUDY.

Among the advantages arising from this mode of *studying* and *hearing* the lessons, are the following:—

1. It secures an accurate examination of every part of the text, and accustoms the pupil to relate his views of the subject connectedly, without leading questions to be answered only in monosyllables.

2. It is an immense saving of time on the part of the class, and of throat on the part of the *teacher*—the question or suggestions of the topic being given to the pupil by the medium of his own eye.

3. It saves the labor of drawing the diagrams on the blackboard,

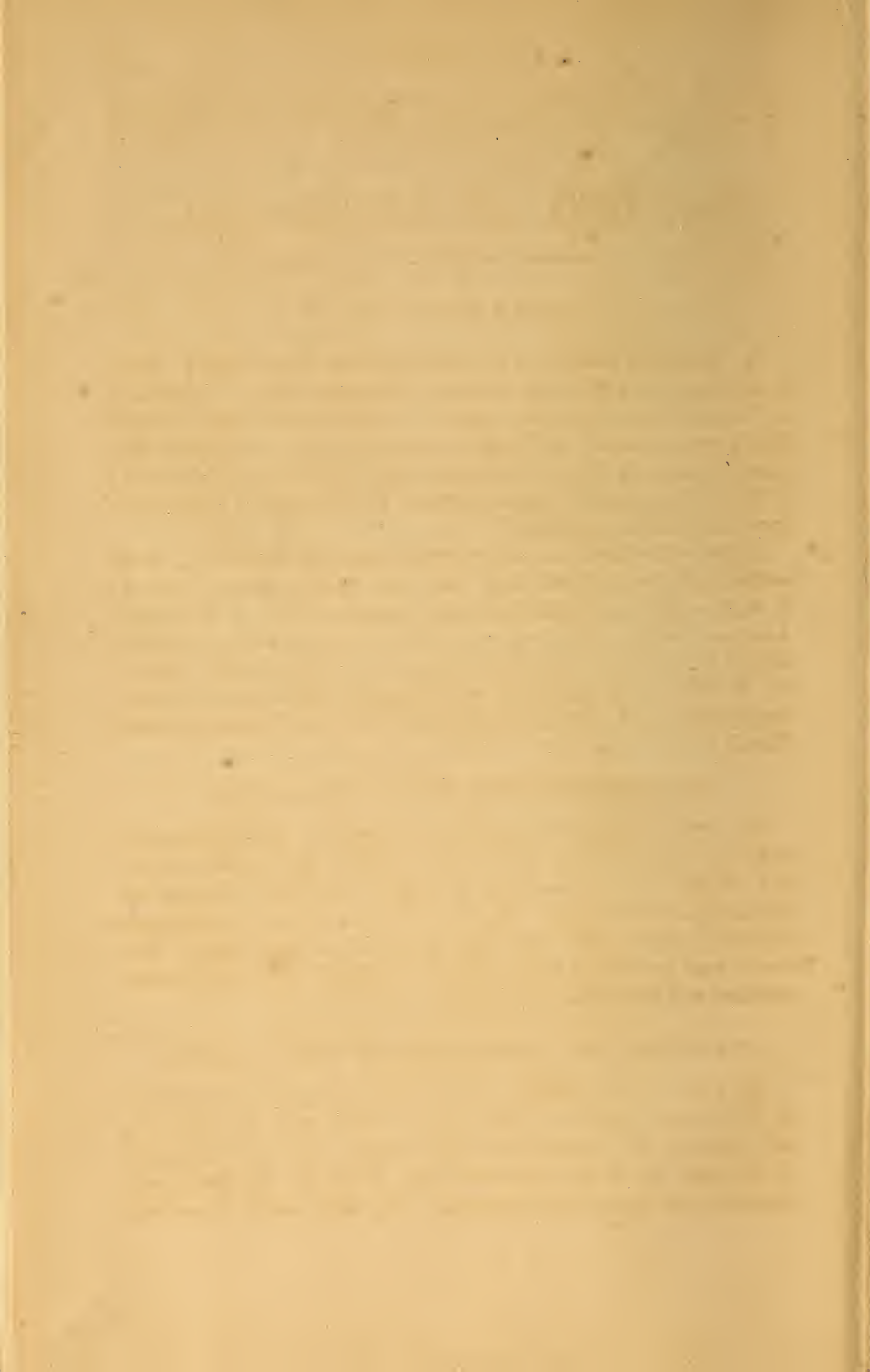
in order to separate them from the text for recitation use, especially in reviews, however frequent they may be.

4. It secures all the advantages of the purely topical method of conducting a recitation, without the unnatural forcing of the memory to retain a series of heads, oftentimes as disconnected as a long series of abstract numbers consecutively arranged.

Finally, it is the method to which the writer of these suggestions was at first gradually compelled to resort, as his classes in the physical sciences, from numbering ten or twelve pupils, began to number from one hundred to one hundred and fifty, and even more during some terms in the year. But, after an experience of several years' adoption of it in all the physical sciences taught in his school (in which, on account of the size of the classes, it is his only possible method of conducting a recitation), he has become so thoroughly convinced of its utility, that it is employed throughout his school, so far as the nature of the study, and the arrangement of the text-books, renders it practicable; and with the full conviction that it is worthy the consideration of his fellow-teachers, he submits the plan, with the distinct avowal that he has no other interest in placing it before the public, than simply to discharge a sacred duty arising from the mutual obligation of all teachers to give to each other the benefit of their experience.

J. W. P. JENKS, *Principal of Pierce Academy.*

MIDDLEBORO', MASS., Dec. 12th, 1853.



QUESTIONS AND ILLUSTRATIONS.

INTRODUCTION.

1. WHAT are essential to the existence of all living bodies? What is the matter of which such bodies are composed called? 2. What is the matter found in minerals called? 3. Do minerals grow? How? Are they nourished? 4. What is essential to the completeness of a plant or animal? Can any organ maintain an independent existence? 5. Upon what parts is a plant dependent for its vitality? Upon what parts is an animal dependent? 6. In what conditions may we study organized matter? 7. What science is derived from the first, and what from the second method? 8. With what does Physiology make us acquainted? 9. What does Anatomy teach? 10. How are Anatomy and Physiology naturally divided? 11. How are animal Anatomy and Physiology divided? 12. To what orders of animals are Comparative Anatomy and Physiology devoted? 14. Why is Physiology divided into Comparative and Human?

CHARACTERISTICS OF PLANTS AND ANIMALS.

16. How are plants and animals distinguished from unorganized bodies? How are plants nourished? 17. How are animals nourished? What do animals always possess? 18. What functions are peculiar to animals alone? 19. What is said of the period of existence of plants and animals? 20. What is the natural age of man? How does it vary in different communities? In proportion to what are communities and individuals long-lived?

STRUCTURE AND COMPOSITION OF ANIMAL BODIES.

21. How are the substances which compose animal bodies divided? 22. How many pounds of fluid may be drawn from the body of a man weighing one hundred and fifty pounds? How can the weight of the body be farther reduced? 23. When are the fluids most abundant and when least abundant? 25. How many elementary

substances are there in the human body? 26. Which are the four essential elements? 27. What are the solid portions of the body called?

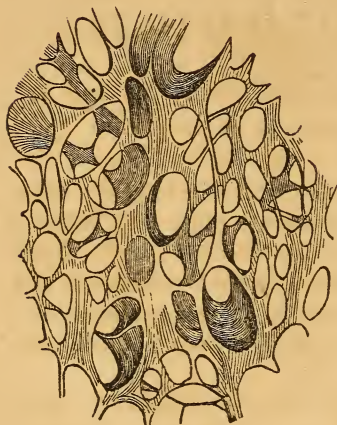


Fig. 3.

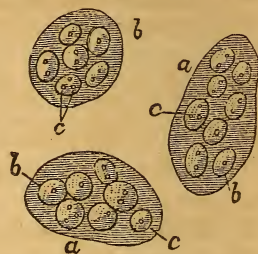


Fig. 1.

28. Of what are the tissues made up? 29. What are granules? Where are granules found? 30. What are nuclei? 31. What are cells? How are cells developed into tissues? 32. What are tubules? 33. What are filaments?

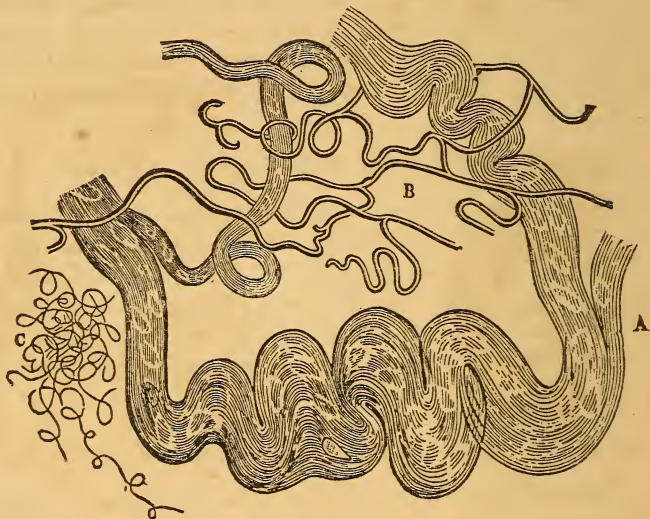


Fig. 2.

34. What are fibres? 35. What is a tissue? 36. What is an organ? 37. What is an apparatus? 38. What is a system?

40. What tissue is the primary form of all others? How is the cellular tissue formed? How is the cellular tissue sometimes inflated? 41. Where is the cellular tissue found? What is its chief use? 42. What different names have been given to the cellular tissue?

CIRCULATION OF THE BLOOD.

43. How is the process of nutrition carried on in organized beings? What is this fluid called in plants?—in animals? 44. What is the color of the blood in insects?—in the mammalia, birds and reptiles? 45. How does the blood coagulate? 46. Of what is the serum composed? 47. Of what tissues does albumen form a large proportion? What are some of the characteristics of albumen? 48. What proportion of the blood is water? What circumstances influence this portion of the blood?



Fig. 4.

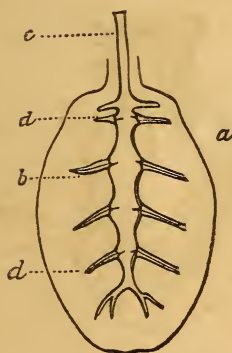


Fig. 5.

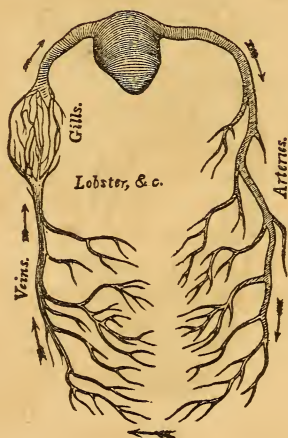


Fig. 6.

49. Of what is the clot composed? 50. What is the color of fibrin when pure? What is its peculiar property? In what is it

found? How does the coagulation of the blood form an imperfect analysis of the blood? 51. What is the color and form of the blood discs? What is the size of the blood discs in different animals?

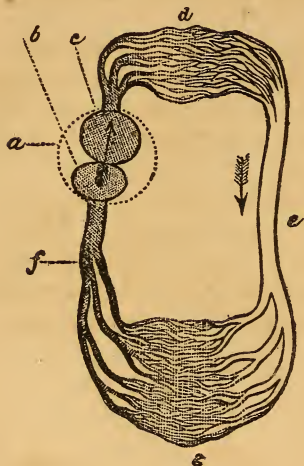


Fig. 7.

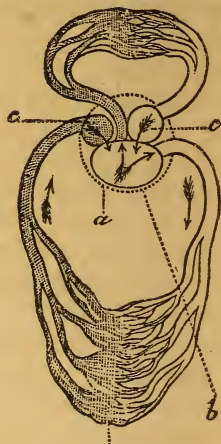


Fig. 8.

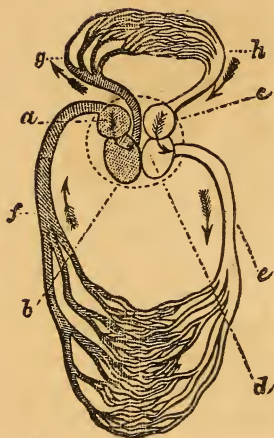


Fig. 9.

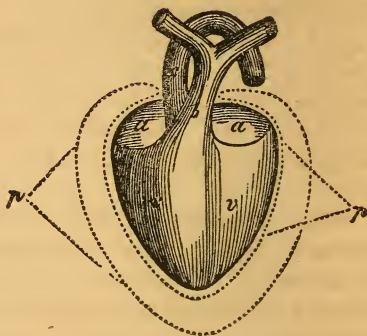


Fig. 10.

What the number? Under what circumstances is the iron found to be diminished? What is the remedy in such cases? In what vital process do the blood discs perform an important office? 52. What

elements is the blood found to possess by chemical analysis? What does the blood carry to every part of the system? What does the blood take up and carry off? 53. What is the circulating apparatus? What the circulation? 54. What is the condition of the circulatory apparatus in different orders of animals?

55. How is the blood sent to the various parts of the body in insects? 56. How in the crustacea? 57. What is the circulating apparatus in fishes? 58. What in reptiles? 59. Describe the heart, as found in mammalia and in birds. 60. What is the form of the double heart? Where is the heart situated in man?

61. How is the heart protected from friction against other organs? Describe the pericardium. 62. How is the heart divided? Which half has the thickest and strongest walls? Why are the walls of the left half thicker and stronger than the right? How do the walls of the auricle compare with those of the ventricle? What is the office of the auricle?

63. How are the auricles and ventricles separated from each other? How are the valves attached to the walls of the ventricle? 64. Describe the semi-lunar valves. 65. What consequences follow disease of the valves? 66. What vessels are the channels of communication between the heart and the various parts of the body? 67. Describe the arteries. 68. What is the use of the external coat of the artery? 69. Of what is the middle or fibrous coat composed? 70. What advantages are derived from the elasticity of the middle coat? How is hemorrhage sometimes arrested in the smaller arteries?

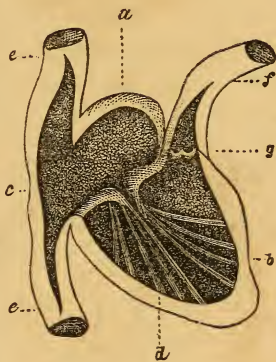


Fig. 11.

What is usually necessary to arrest hemorrhage from the large arteries? How may the contractions of the divided end of an artery be increased? 71. Describe the internal coat. 72. How do the extremities of the arteries finally terminate? How is the danger of obstruction in the large trunks obviated?

73. Of how many coats are the veins composed? What is their structure? How do the veins commence? How does the velocity of the blood in the veins compare with that of the arteries? What is said of the valves in the veins?

74. Describe the capillaries. What functions are performed through the capillaries? 75. Describe the course of the blood in the circulation of man. What changes take place in the capillaries? 76. What is the course of the blood from the right ventricle? 77. Of

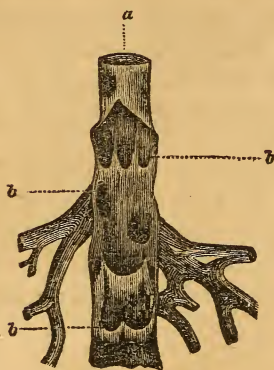


Fig. 12.

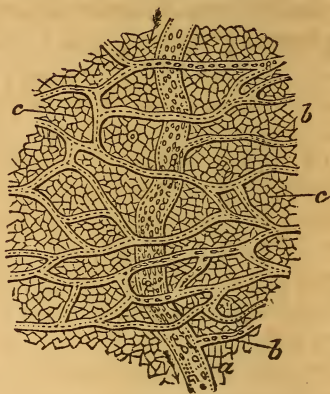


Fig. 13.

how much blood does the heart of a man in middle age empty itself at each contraction? What is the amount of the propelling force of the heart?



Fig. 14.



Fig. 15.

How many times does the heart contract in a minute? How long a time will twenty-eight pounds of blood require to pass through the heart according to this estimate?

78. How long a time will be necessary, if we form our opinion from the rapidity with which poisons are transmitted? 79. What is the frequency of the heart's contractions during the first year?—the seventh?—in middle life?—in old age? What other circumstances affect the frequency of the heart's action? What temper of mind is conducive to long life?

RESPIRATION.

80. What is respiration? What is said of the necessity of respiration in plants and in animals? 81. How does the process of respiration take place in plants? Of what is carbonic acid composed? How do plants dispose of the oxygen?—how the carbonic acid? 82. How do animals dispose of the oxygen?—how the carbon? How do plants affect the air? 83. What is the necessary condition for the function of respiration in animals?

How is this principle modified in different groups of animals? 84. How does respiration take place in the hydra? What is this kind of respiration called? In what other orders of animals is this kind of respiration found? What is said of its importance in cold-blooded animals?—in the frog? 85. In how many large groups may all the animals which possess a special organ of respiration be divided? What modification in each of these? 86. Describe the respiratory organs in the lowest group of water-breathing animals.

What is said of the form and attachment of the fringes? 87. Describe the re-

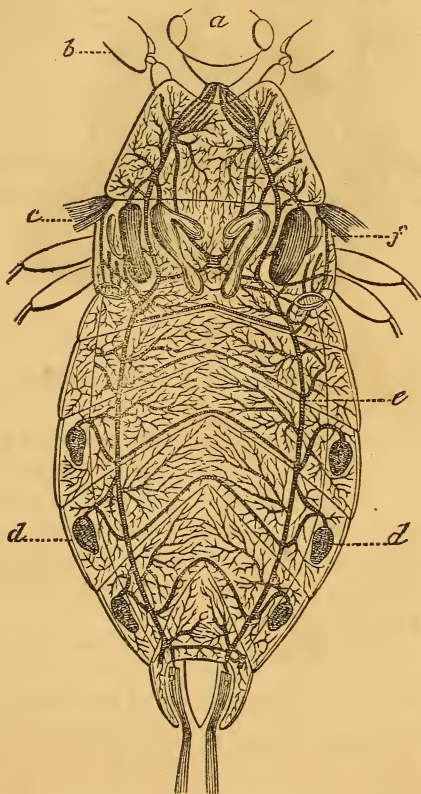


Fig. 16.

spiratory organs of fishes. 88. The gills of fishes are made up of what? How do the fibres preserve their shape? What are distributed on the surface of the fibres? What is said of the extent of this surface exposed to the action of the air absorbed from the water? How great is it in the skate? Does the water itself act on the membrane? What does? How are fishes affected by being kept in water which has no access to fresh air?

What takes place when they are removed from the water to the air? What is the cause of death? 89. How is air conveyed to the circulating fluids of insects? Describe the air-tubes of insects. 90. What do the highest group of air-breathing animals possess? In what animal is the lung seen in its simplest condition? 91. Describe the respiratory organs of a frog—92. a turtle.

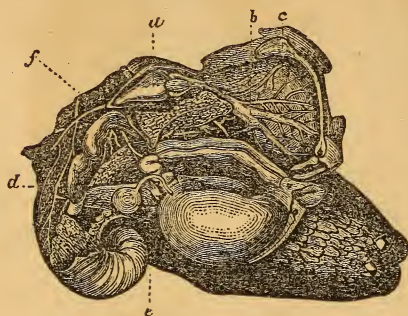


Fig. 17.

93. Describe the respiratory organs of a bird. How do birds compare with other animals in the frequency of their respirations? What special benefit do birds derive from the large amount of air contained in their sacs and bones? 94. Upon what does the capacity of the lung depend? In what group of animals are the air cells most numerous? 95. How

many air cells are there in the human lungs? How is each air cell constructed?

96. Of what is the whole substance of the lungs mainly made up? 97. How are the lungs supplied with air? Describe the larynx. How is the larynx situated, and what is it sometimes called? 98. What other use has the larynx besides to give passage to the air? 99. How is the trachea formed? 100. How does the trachea divide on entering the chest? How do the bronchi divide? 101. Where are the lungs placed in man?

How may we judge of the size of the lungs in different individuals? 102. Describe the chest. 103. How are the walls of the thorax formed? 104. Describe the ribs—105. the diaphragm. 106. How is the internal surface of the chest lined?—and how is it kept moist?

107. How is the cavity of the chest increased and diminished in size? 108. What is the position of the ribs and diaphragm when the

respiratory organs are at rest? What change takes place in the act of respiration? 109. How is the chest filled when it is enlarged?

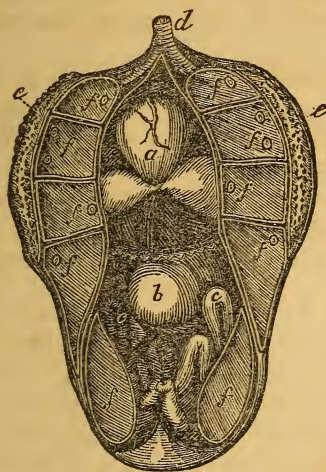


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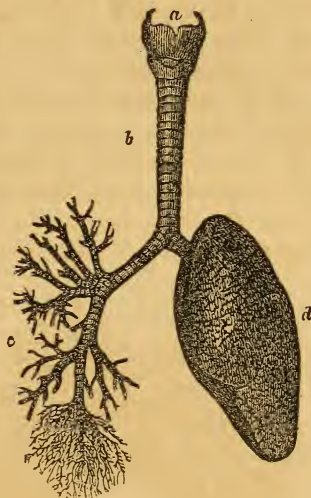


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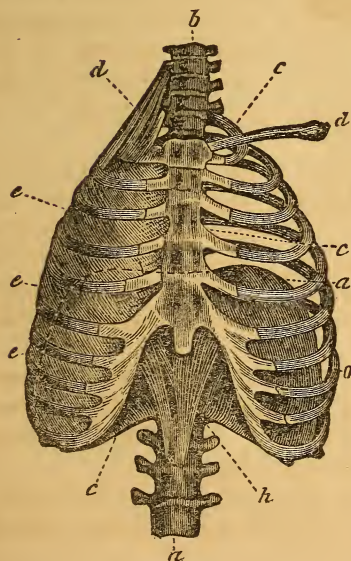


Fig. 21.



Fig. 19.

By what organs is the active process of respiration performed? 110. How is respiration carried on when the ribs are confined? How when the diaphragm? 111. What law of our organization do these parts teach us?

When the action of the respiratory organs is in any way restrained, what is the effect on respiration? 112. What is the

number of respirations in adults? How is it affected by exercise or by excitement? 113. How much air is taken into the lungs at each respiration? How much air will pass through the lungs in an hour?—in a day? 114. How is the air changed in passing through the lungs? 115. What change takes place in the blood during this process? 116. How much blood is subjected to this renovating process every minute? What is exhaled from the blood?

117. If the lungs be diseased or the air be impure, what is the effect? 118. What is the effect of sleeping in poorly-ventilated apartments? 119. How are public assemblies affected by impure air? 120. What is said of the importance of a due supply of pure air? With what should every apartment we occupy be provided? 121. What proportion of our race are scourged with lung diseases? 122. How should every room be ventilated?

ANIMAL HEAT.

123. What relation has the power of maintaining animal heat to the process of respiration? 124. How does the respiration and temperature of birds compare with other animals? What is the temperature in the mammalia?—in man? What is it in fevers? What during sleep? 125. What is the temperature and respiration of young animals? How do they bear exposure to cold? 126. What are those animals called which possess the power of maintaining a uniform temperature? What are those called which do not possess this power? What order of animals are cold-blooded? 127. What is the temperature of the snail? What of fishes? What is the temperature of reptiles? 128. What remarkable provision exists in some cold-blooded animals for preserving life at a low temperature? What examples are given? How is this fact explained?

129. What does a comparative view of the process of respiration, in connection with the development of animal heat, show? With what does the carbon of the blood combine? What is formed by this process? How does it compare with combustion? 130. Are the lungs the only source of animal heat? What other source is there? 131. What causes affect the health of the lungs? When and where do diseases of the lungs prevail most? 132. What is necessary to guard against lung diseases? What care should be exercised in regard to clothing?

TOPICS FOR REVIEW.

WHAT are the characteristics of inorganic and organic matter? Define Physiology—Anatomy—Comparative Anatomy and Physiology—Human Anatomy and Physiology. Why is Physiology divided into Comparative and Human? How are plants distinguished from unorganized bodies? Describe the various tissues of the body. Describe the blood of insects—of fishes—of mammalia, birds, and reptiles. What change takes place when blood is exposed to the air? How is the circulation of the blood effected in insects?—in crustaceæ?—in fishes?—in reptiles?—in man? Describe the heart, its cavities, its valves—the arteries, the veins, and the capillaries. What is the course of the circulation in man? How often is the blood supposed to go the round of the circulation? What circumstances vary the frequency of the heart's action? What is respiration? What is the essential condition for respiration? How is it modified in different groups of animals?—in *water-breathing*?—in *air-breathing* animals? Describe the respiratory organ of insects—of the snail—of the frog—of the turtle—of birds. Describe the larynx, the trachea, the bronchi, and the thorax in man. What are the active organs of respiration in man? How may the respiratory organs be affected by dress? How much air is taken into the lungs at each inspiration? What changes does the air undergo in the process of respiration? What relation has the power of maintaining animal heat to the process of respiration? How does the respiration and temperature of birds compare with other animals? What is the temperature in the mammalia?—in man?—in fevers?—during sleep?—in young animals? What are called warm-blooded animals? What remarkable provision in cold-blooded animals for resisting the cold? Are the lungs the only source of animal heat? How may lung diseases be prevented?

DIGESTION.

133. WHAT is digestion? 134. From what source is the food of plants obtained? How do animals derive their nourishment? 135. With what organs are all provided? 136. In what animals are the digestive organs very simple? 137. What do we find in the higher orders? 138. What is said in regard to the apparatus for masticating the food?

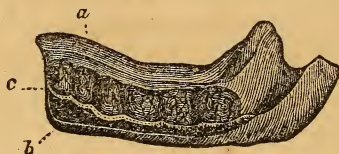


Fig. 22.



Fig. 23.

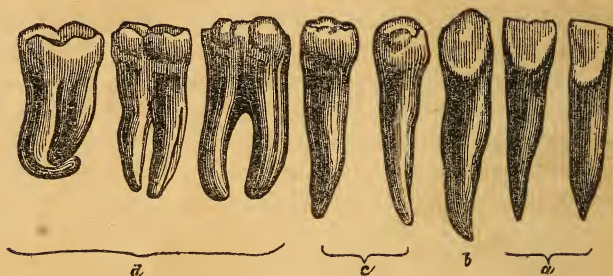


Fig. 24.



Fig. 25.

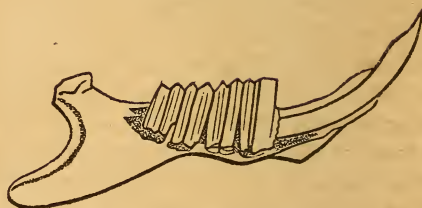


Fig. 26.

139. How is food divided when the process of digestion is performed rapidly? 140. How do the organs of mastication indicate the class to which each animal belongs? 141. What is said of the jaws of insects? 142. How is mastication performed in most of the higher

animals? 143. How many kinds of teeth are there in man and the mammalia? Describe each. 144. How many sets of teeth are there? 145. How many teeth are there in the first set? How many in the second? When does the last molar make its appearance? 146. Of what are the human teeth composed?



Fig. 27.

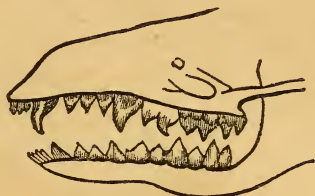


Fig. 28.



Fig. 26.



Fig. 29.



Fig. 30.

Describe each structure of the teeth. 147. How is the enamel distributed on other animals? Describe the incisors of a rabbit. 148. Describe the teeth of grazing animals. 149. What is said of the form of the teeth? What is the form of the teeth in animals which live on flesh?—on insects?—on fruit? 150. What is the form of the teeth in fishes and reptiles?

151. How are the teeth brought into action? How does the lower jaw act in different animals? 152. Describe the movements of the lower

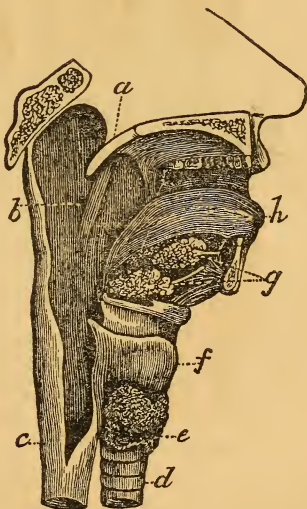


Fig. 31.

jaw in man. 153. What is insalivation? Where are the salivary glands situated? 154. What is the use of the saliva? When is the saliva secreted? How is the secretion of saliva affected by fevers? 155. How is digestion affected by an imperfect mastication of the food? 156. How is food transmitted to the stomach?

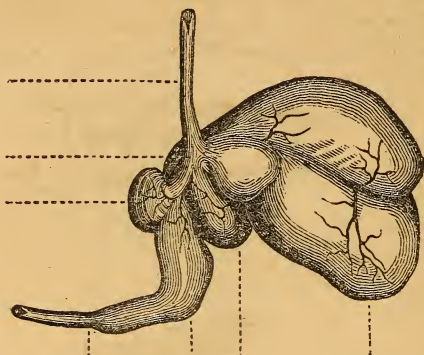


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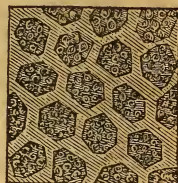


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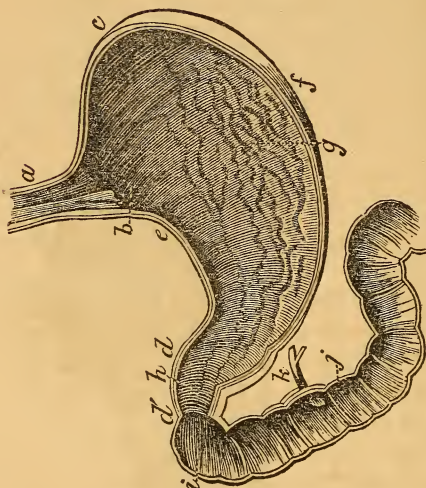


Fig. 33.

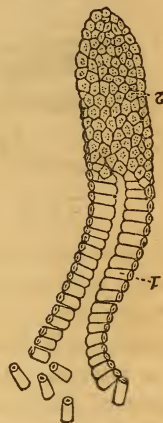


Fig. 35.

157. What is said of the form and size of the stomach? In what class of animals is it found in its simplest condition? Describe the stomach of a hydra. What variation is found in the planaria? 158. Describe the stomach of the higher orders of animals. 159. In what

class of animals is the stomach the most complex? How many cavities are there in the stomach of a ruminating animal? Describe the course of the food through the several cavities. 160. How is the stomach modified in birds? 161. How is the gizzard placed in insects?

162. What do we observe by a comparative view of the stomach in different animals? 163. Describe the human stomach. How is it placed? What is its average capacity in the adult? How many openings has it, and what are they called? 164. How many coats does the stomach possess, and what are they?

165. Describe the serous coat of the stomach—the muscular coat—the mucous coat. 167. What does the mucous coat secrete? 168. What is secreted by the gastric follicles? What is the use of the gastric juice? Describe these follicles.

169. How does the gastric juice act on all kinds of food? 170. With what does the amount of gastric juice correspond? When is it secreted? How is the food disposed of when more is taken than is required? 171. When is the sense of hunger experienced? When does it cease to be felt? What is the consequence of swallowing the food twice as fast as it should be? What evils result from rapid eating? 172. Describe the manner in which the food is moved backward and forward in the stomach. How long does this process last? 173. What circumstances facilitate the action of the gastric juice on the food?

174. Is the value of a particular article of diet in proportion to its digestibility? What properties render an article of diet nutritive? 175. What is the food converted into when digestion is complete? 176. What should be the quantity of the food? 177. What time should be allowed between each meal? Why should the intervals between the meals be shorter with young persons than with adults? 178. How does exercise affect digestion?

179. What effect has the mind on digestion? 180. How do drinks affect digestion when taken in large quantities? How does the stomach get rid of the fluids? 181. What course does the food take when it has become sufficiently digested to form chyme? Describe the pyloric orifice of the stomach. 183. Into how many portions is the alimentary canal divided? What is the length of the alimentary canal in the tiger?—in the sheep?—in man? 184. Describe the small intestine—the large intestine? 186. How many coats have the intestines? 187. What glands are imbedded in the mucous membrane of the intestine?

189. What changes does the food undergo after passing out of the stomach? 190. Describe the pancreas. What is supposed to be the use of the fluid secreted by the pancreas? 191. Describe the liver.



Fig. 86.

How is the gall-bladder situated? 192. What are the properties of the bile? 193. How is the chyle formed? How is it absorbed? 194. What movements force the passage of the food along the alimentary canal? 195. What effect does the wearing of tight garments have on the natural movements of the bowels and on health?

ABSORPTION.

196. What is absorption? 197. What tissues possess the power of absorption? 198. To what is a large portion of the weight of the body owing? How much of its weight does muscle lose in drying?—blood, how much? To how small a weight have mummies been found reduced? 199. By what vessels is the process of absorption performed? 200. What are the lymphatics? From what do lymphatics derive their name? 201. What are the lymphatics called that have their origin in the mucous membrane? 202. Describe the lymphatics.

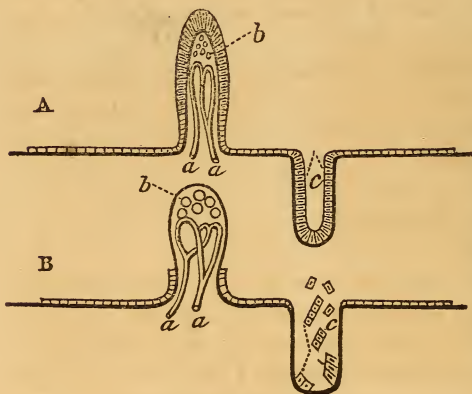


Fig. 39.

Fig. 37.

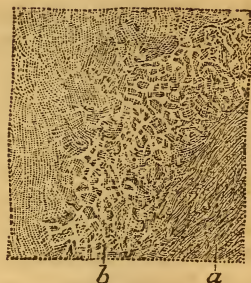


Fig. 38.

How do they commence? 203. What is the appearance of the lymphatics externally? How are the valves formed? Of what use are the valves? How is the flow of lymph effected in reptiles? 204. What are lymphatic glands? What are they sometimes called when they become inflamed? 205. How are the contents of the lymphatics affected by passing through these glands? 206. How do the lacteals

commence? Describe a villus. 207. What do the lacteals unite to form? Through what glands do the lacteals pass? 208. Describe the thoracic duct. Into what does the thoracic duct discharge its contents?

209. How does absorption by lymphatics or lacteals take place? What materials can traverse the walls of the lymphatics? What remarkable property does this system of vessels possess? 210. Do blood-vessels possess any power of selecting materials? What substances may be absorbed by blood-vessels? 211. How are substances taken up in the alimentary canal? 212. How is absorption performed from the skin? How are poisons known to take effect? 213. Under what circumstances does absorption from the skin take place with great activity?

214. Why are contagious diseases acquired more easily after fasting than after a full meal? What causes render the system more susceptible to disease? Among what class of persons are epidemics most fatal? What are the best safeguards against contagious diseases? 215. What creates a necessity for a constant supply of food? What materials are taken up by the lymphatics? How may animals live for a long time on their own solids? What is said in regard to hibernating animals?

216. Through what channel are the materials for the nourishment and growth of the body chiefly taken up? What portions are taken up by the lacteals, and what by the veins? 217. What is said in regard to absorption by the skin?

NUTRITION.

218. What is nutrition? In what does nutrition essentially consist? 219. By what organs are the elements of nutrition prepared? How are the elements of nutrition taken up? 220. What circumstances may be regarded as essential to nutrition? 221. What changes are the tissues constantly undergoing? How are the particles removed from the body supplied? 222. What is said of the life of each individual particle? In what tissue are the changes the most frequent? 223. What takes place with every action of any part of the body?

How is this illustrated by a movement of the arm? 224. The rapidity of the changes are in proportion to what? What is the effect of exercising particular limbs? 225. Have physiologists been able to determine the means by which each tissue selects those elements which form its own composition? 226. In what is the process of nutrition

supposed to consist? 227. When is the body said to increase in size? When is it said to become emaciated? How does the activity of nutrition vary at different periods of life?

SECRETION.

228. What is secretion? What is said of the secretions obtained from the sap of plants? What are some of the secretions obtained from the sap of plants? What are some of the secretions obtained from animals?

229. How is the process of secretion performed in animals and in plants? What power do the cells seem to possess? How is the secreting surface increased in particular parts? 230. What two kinds of materials are secreted from the blood of man? 231. What are the principal divisions of the secreting apparatus? 232. What organs are protected by the serous membrane? What is secreted by the serous membrane? 233. How are the ends of the bones protected?

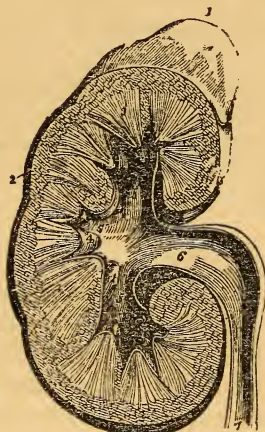


Fig. 40.



Fig. 41.

234. What passages are lined by the mucous membrane? What is the secretion of the mucous membrane called? What is its use? 235. What are the most important of the secreting glands? 236. In what animals is the liver found? Of what is the liver made up in man and the mammalia? What does each lobule contain? 237. Describe the use of the hepatic artery—the portal vein—the hepatic vein.

How is the bile taken up from each lobule? 238. What is said of the function of the liver? How is the health affected by inaction of the liver?

What is the object of the secretion of bile? 239. What is the function of the kidney? 240. Of what is the cortical substance of the kidney composed? Of what is the central or medullary portion? 241. What do the salivary glands include?

Of what are the salivary and lachrymal glands composed? 242. What circumstances influence the quantity and character of the secretions? How do emotions of the mind influence the secretions? By what organs is the function of secretion performed? 243. What substances are thrown off from the lungs?—the liver?—the kidneys?—the skin?

TOPICS FOR REVIEW.

WHAT is digestion? How are plants nourished? How are animals? What is mastication? What are the organs of mastication? How varied in different animals? Describe the teeth of man—of the rodentia—of herbivorous—of carnivorous animals—of reptiles. What is insalivation? How is deglutition performed? Describe the stomach in its most simple condition—in its most complex—in birds—in insects—in man. Describe the coats of the stomach. How is the gastric fluid formed? What are its uses? When is a sense of hunger felt? Why is rapid eating injurious? How long does the process of digestion last? How is the food moved about the stomach? What conditions render the food more easy of digestion? What circumstances facilitate the process of digestion? What changes in the food after it passes out of the stomach? Describe the alimentary canal. How many coats have the intestines? Describe the pancreas—liver—the bile. How is chyle formed? What is absorption? What tissues possess the power of absorption? Describe the lymphatics—the lacteals. How are substances taken up in the alimentary canal? How is absorption performed from the skin? Why is there a necessity for a constant supply of food? What is nutrition? What change is the body constantly undergoing? Upon what does the rapidity of the changes going on in the body depend? In what is the process of nutrition supposed to consist? What is secretion? What substances are secreted by plants?—by animals? How is secretion performed? What are the most important secreting glands? Of what importance is the function of the liver to health? Describe the salivary glands. By what organs is excretion especially performed?

THE SKIN.

244. What are the principal layers of the skin? 245. How is the epidermis formed? What becomes of the external layers of the epidermis? 246. How is the epidermis raised from the true skin? How are the minute scales of which the surface of the epidermis is composed, cast off? How are the different varieties of complexion caused? 247. Where are the pigment cells deposited? 248. Why is the epidermis a hard insensible membrane?

How is the epidermis affected by pressure? 249. How is it marked on the surface? By what is the epidermis perforated? 250. Describe the dermis or true skin. 251. What lies beneath the true skin? 252. Of what is each papilla composed? What is the blood-vessel? What sense is located in the papillæ? Where are they the most densely set?

253. Where are the perspiratory glands located? How do the perspiratory ducts pass through the skin? How numerous are the perspiratory ducts? 254. What is constantly exhaled from the perspiratory ducts? What is sensible and what insensible perspiration? How much is estimated to be exhaled from the skin of an adult daily? How may the perspiration be increased or diminished? 255. Of what use in the animal economy is this watery exhalation? What matters are carried off? 256. Where are the oil glands located? Where do their ducts open?

In what parts are the oil glands most numerous? Of what use is the oily secretion? 257. What purpose do these glands serve on the margin of the eyelids? What are these glands called when they become inflamed? 258. What are regarded as appendages of the skin? How does each hair originate? How are the hairs softened? How is the coloring matter secreted? What causes the hair to become gray? What is the form of each hair? What is the form of the end of hair? What part of the hair is the smallest in most animals? How do most animals shed their hair?

In what manner do deer shed their antlers? 259. How are the nails produced? Describe the insertion of the nail and the process of its growth. 260. What is the use of the nail? 261. What do the feathers, hoofs, and horns of animals resemble in their structure? For what are the feathers of birds remarkable? How are they formed?

NERVOUS SYSTEM.

262. Of what does the nervous system consist? 263. Of what is the brain the centre? 264. What is the office of the nerves? 265. How are the nerves divided? What illustration can you give of the function of both? Have the two classes of nerves the same origin from the nervous centre? 266. Do nerves originate impressions? How is each class of nerves stimulated? 267. How does nervous force move along a nerve? Can a single nerve-fibre convey more than one kind of impression? What does a nerve of motion convey? What a sensitive fibre?

268. How are the motor fibres distributed to the muscles? How do the nerves of sensation originate? What sense is seated in the ramifications of the nerves of sensation? 269. How does an individual become conscious of what is passing around him? What takes place before any movement of the body can be effected? 270. What are those movements called which do not seem to be excited by impressions made on the brain? Why are they called reflex movements? 271. In what changes are the reflex movements particularly concerned?

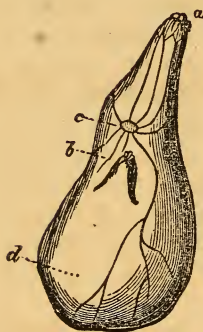


Fig. 42.

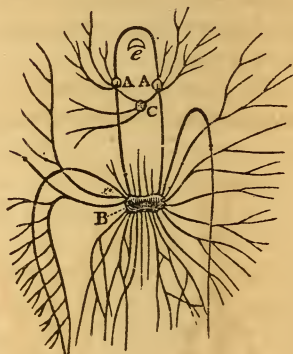


Fig. 43.

272. What are the centres of reflex action? What particular advantage may be supposed to result from this arrangement? 273. How may the true nature of reflex action be more easily comprehended? 274. In what animal is one of the simplest forms of the nervous system found? Describe the nervous system of the ascidia and the phenomena of life exhibited by that animal—275. of the pecten.

276. What is said of the ganglia in the higher orders of animals?
 277. How does the nervous system of insects compare with that of the



Fig. 44.

Mollusca? Of what does the nervous system of insects consist? How are the ganglia united? How do the ganglia of the perfect insect differ from that of the larva or caterpillar? 278. Describe Fig. 45, with the difference between A and B. 279. Explain the arrangement of the ganglia of insects.

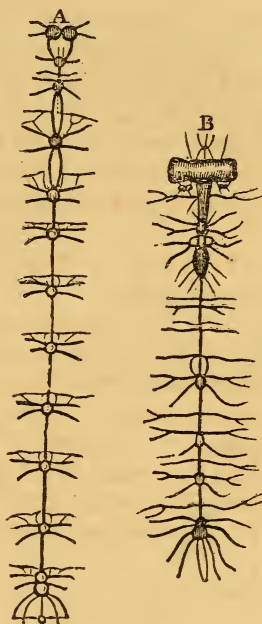


Fig. 45.

280. How is it shown in the case of the centipede that consciousness depends on the cephalic ganglia? 281. How

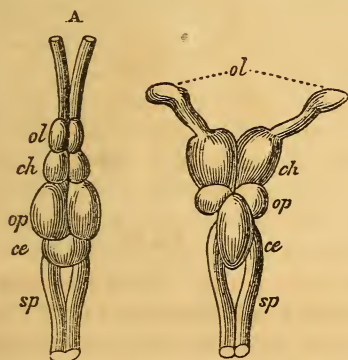


Fig. 46.

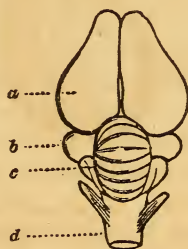


Fig. 47.

are the ganglia arranged and protected in vertebral animals? Of what

parts does the brain of the higher vertebrata consist? What ganglia at the base of the cerebrum? 282. What is said of the brain of a fish? Describe Fig. 46. What parts are large and what small in a fish? What is the comparative size of the cerebral hemispheres in birds?

283. What is said of the cerebellum?—the spinal cord? How do birds compare in intelligence with the animals previously considered? 284. How are the cerebral developments in man?—how the spinal cord? How is the surface of the brain in man? 285. Of what does the nervous system of man or the higher animals consist? Of what is the cerebro-spinal system composed? What has it been called?

With what is the sympathetic system connected, and what has it been called? Of what does it consist? 286. What is the spinal cord? How is the canal in which it is lodged formed? What is the extent of the spinal cord?—and of what does it consist? How are the two halves united? How is each half divided? What enlargements in the spinal cord?



Fig. 48.

287. How many nerves are given off by the spinal cord? How many pairs are given off in the neck—back—loins—pelvis? How does each nerve arise from the spinal cord? Of what fibres do the posterior roots consist?—the anterior? What would be the effect of irritating the anterior or the posterior, if the spinal cord of an animal was laid bare? 288. What two functions does the spinal cord perform? Explain how it acts as a conductor of nervous impressions. What are the effects of lacerating or dividing the cord? 289.

Explain how the spinal cord is a nervous centre of reflex actions. 290. Does the spinal cord possess any degree of independent power? How does it differ from that of the brain?

291. Where is the medulla oblongata? How is it formed? What is said of its columns? With what functions are its nerves connected? 292. How does the medulla oblongata differ from the rest of the spinal cord? 293. Of what importance to the maintenance of life are the functions of the medulla oblongata? By what experiments has it been proved that life can be maintained so long as this portion remains uninjured?

294. What has been said of the power of reflex action in this portion? What effects are produced on the respiratory movements by stimuli applied to other portions of the body? How are convulsions often produced? What is usually the immediate cause of death in

such cases ? 295. Of how many portions does the brain consist, and what are they called ? What portion of the cranium is occupied by the cerebrum ?

How is the cerebrum divided ? How are the two halves connected together ? What is the external appearance of each hemisphere ? 296. Of what is the nervous tissue of the cerebrum composed ? How are the white and gray substances disposed ? How may the manner in which the two substances are disposed be illustrated ? What is the effect of this arrangement ? What proportion of the whole amount of blood has been estimated to be sent to the brain ? 297. What are the internal cavities called ?

How do they communicate with each other ? 298. Where is the cerebellum situated ?—how is it divided ? Of what two substances is it composed ? What is the appearance of the matter when divided vertically ? 299. How is the brain protected ? What was the origin of the name applied to the dura mater and pia mater ? 300. Describe the dura mater. What is that portion of the dura mater called which divides the two hemispheres ?

What other processes are there ? 301. Describe the arachnoid membrane ? 302. Describe the pia mater. 303. How many pairs of nerves are given off from the brain ? What are they called ? 304. Where are the first pair distributed, and what is its office ?—the second ? What are the third, fourth, and sixth pairs ? What is the fifth pair ? How is it divided ? Where is each branch of the fifth distributed ? 305. What is the seventh pair ?—the eighth ? What is the origin of the ninth pair ? What organs does it supply ? To what parts do the eleventh and twelfth give motion ? What two sets of filaments are all these nerves supposed to contain ?

306. What is said in regard to the functions of the cerebellum ? How is it regarded by the most intelligent physiologists ? What do experiments on living animals show in regard to the formations of the cerebellum ? 307. What is most probably the function then of the cerebellum ? 308. What is said in regard to the development of the cerebellum in the cat tribe and in birds ? In what class does the cerebellum acquire its highest development ?

309. What is said in regard to the influence of each half of the cerebellum ? 311. Is reason peculiar to man ? When may an animal be said to reason ? How may we discover the presence of intelligence in animals ? What example is given of different degrees of intelligence in an animal ? What seems to be the nature of the action of insects ? 312. What is said in regard to birds ?

In what actions do birds seem to be governed by instinct, and in what by intelligence? 313. How does the amount of intelligence in different animals compare with the development of the cerebral hemispheres? Is all the difference produced by size alone? What other circumstances are to be taken into the account? What is said of the size of the cerebellum, compared with that of the spinal cord? How does this rule hold in regard to different men? 314. Why may two men whose brains are of the same size differ widely in mental vigor? Under what circumstances will a large brain surpass a small one in power?

What has been said in regard to the size of the brain in men who have been distinguished for their talents? What examples are given of large brains? How is the brain in idiots? 315. How may the size of the brain be estimated? 316. In what class is the facial angle more open than in all others? How does it vary in different races? What is the facial angle of an European or an American—of a negro—of a monkey? 317. What may we regard as the connecting link between the mind and the body? How may we regard all the organs of the body? What parts are made to express the emotion of the mind? What control does the mind exert over the body? 318. What then may we regard the body? How is the influence of the mind upon the body reciprocated?

What illustration is given to show this fact? 319. Upon what does the intellect stamp itself? As we ascend the scale of being, how is intelligence marked? How is it shown that the nervous power is at its highest point in man? What is said in regard to the cares and anxieties of man, compared with other animals? When does man obtain the highest perfection? 320. What should be observed in the education of the young?

323. How should the mind be trained in more mature years? Who are usually the best thinkers? What is the effect of keeping the brain constantly at work? Who are the men who have done the most for the world? Why does genius so often find an early grave?

TOPICS FOR REVIEW.

DESCRIBE the layers of the skin—the papillæ—the perspiratory glands—sensible and insensible perspiration—the sebaceous glands—the hair and nails. Of what does the nervous system consist? What is the brain? *What are the spinal cord, ganglia, and nerves? What is the office of the nerves? How do we become conscious of what is passing around us? What must take place before any movement of the body can be effected? What are reflex movements? What are the centres of reflex action? Describe the nervous system of the ascidia—of the pecten—of an insect. How are the ganglia of insects arranged? How is it shown that consciousness in the centipede depends on the cephalic ganglion? How are the ganglia arranged and protected in vertebrated animals? Of what parts does the brain consist in vertebrated animals? Describe Fig. 46, Fig. 47, and the relative size of the different parts in each. How are the cerebral developments in man? What are the two principal portions of the nervous system of man? Describe the spinal cord. How many nerves are given off by the spinal cord? What is the function of the anterior roots?—of the posterior roots? What two functions does the spinal cord perform? What are the effects of lacerating or dividing the spinal cord? Explain how the spinal cord is a nervous centre of reflex actions. Describe the medulla oblongata. What are its functions? What connection has it with the maintenance of life? What are the principal portions of the human brain? Describe the cerebrum. How is it divided? How are its two halves connected together? Of what two substances is it composed, and how are they arranged? Describe the cerebellum. Describe the membranes which envelope the brain. How many pairs of nerves are given off from the brain? What is the function of the cerebellum? In what class of animals does it acquire its highest development? What is the function of the cerebrum? When may an animal be said to reason? How does the amount of

intelligence in different animals compare with the development of the cerebral hemispheres? Is the intellectual power in different men in proportion to the size of the brain? What other circumstances are to be considered? What examples of distinguished men who have had large brains? What is the connecting link between the mind and the body? How may we regard all the organs of the body? What influence has the mind on the body? How should the intellectual and physical powers be developed? What is often the result of premature culture? How should the mind be trained in more mature years? Who are generally the best thinkers?

THE SENSES.

324. How many senses are there? What is the office of the senses? How do we obtain our ideas of form, taste, odor, and sound? 325. Which of the senses is the most universally diffused? What is the extent in man? How is it limited in other animals? What are the organs of touch in insects?

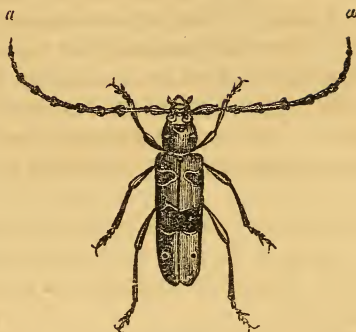


Fig. 49.

326. What is the condition of the body in fishes? Where is the sense of touch most perfectly developed in animals which are covered with hair? What is said of the lips of the horse and the whiskers of carnivorous animals? 327. What are the chief organs of touch in most of the mammalia? In what parts is it possessed very acutely by the elephant and the bat? 328. With what is the true skin in man studded?

With what is each papilla provided? Where are the papillæ the most numerous, and the sense of touch the most acute? What is said of the improvement of the hand by education? How do the blind learn to read? 329. To what parts is the sense of touch almost wholly confined in all animals? Where is the pain the most acute in cases of injury? What may we regard the sense of touch?

330. What is taste? What is its chief purpose? How is the sense of taste excited? What is said of substances that are not soluble? 331. To what parts is the sense of taste chiefly confined? What is said of the papillæ of the tongue?—of their form and size?

Describe the fungiform papillæ. 333. Of what is the tongue itself made up? What is the structure of the tongue in birds? For what other purposes is the tongue of some birds used? What is said of the tongue in reptiles?—in serpents?—in the frog, and the chameleon? What of the tongue of the fish and the bee? 334. How are most of the lower animals directed in the choice of their food?

How is man guided? How do substances naturally loathsome come to be agreeable? What examples are given? 335. Upon what

does the susceptibility of the organs of taste to pleasurable sensations depend? What ensues if indulgence of the appetite is persisted in beyond the actual demand for food? What is said in regard to the sympathy of the organ of taste with the stomach? 336. What is smell? What properties do certain bodies seem to possess? What is said of the particles which emanate from odorous bodies?

How long will musk scent a room without any apparent loss of its particles? What is said of bodies which lose weight by loss of particles? 337. Where is the special seat of the sense of smell? What is the membrane called? 338. The acuteness of this sense is in proportion to what? What is said of the size of the nose in those animals which are remarkable for acuteness of smell? How is the interior surface of the nose greatly increased? 339. Explain the manner in which the odorous particles are made to act on the Schneiderian membrane?

Under what circumstances do the odorous particles fail to make any impression? 340. Do all animals perceive the same odors equally well? In what do carnivorous animals excel?—in what herbivorous? What is said of the deer and antelope? Of what special use does the sense of smell seem to be to this class of animals? 341. How do the herbivorous animals seem to be guided in selecting their food? 342. What is said of the scent of the dog?—the deer-hound?

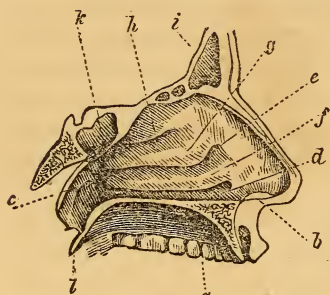


Fig. 50.

343. What is said of the sense of smell in birds and fishes?—what of insects? 344. How may the sense of smell be improved? How is it in the blind? What is said of the Indians of Peru? What examples are given in which this sense has become morbidly sensitive?

345. What is hearing? What is the special organ of hearing? What is the essential part of this organ? 346. Describe the ear, as found in the crab, lobster, &c. How is it inclosed in some species? With what in higher animals does this cavity correspond? Is this part ever omitted in the most perfect development of the organs? 347. What may all other parts be regarded? What parts are added in fishes? What other parts are added in animals which live in the air? 348. Of how many parts is the ear composed in man and most of the mammalia? What are these parts?

349. Describe the external ear. What peculiarity has it in most of the quadrupeds? Do men ever possess the power of moving the external ear?

350. What may be made use of to collect the vibrations of sound by persons who are partially deaf? What effect does it have on the vibrations of sound? 351. What is said of the canal into which the external ear collects the sonorous vibrations? How is it separated from the middle ear? What is its length? How is it protected from insects? 352. Have reptiles and birds any external ear? 353. Where is the tympanum formed in frogs?—in birds? Describe it in man. What other name is applied to the middle ear? With what is it filled? How does it communicate with the external air? Where does this tube terminate? What is its use? What effect do colds sometimes have on this tube?

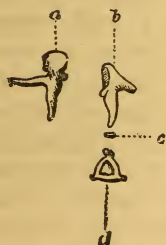


Fig. 51.

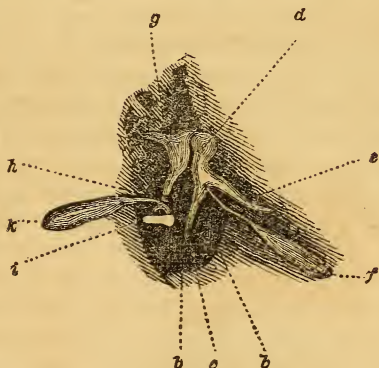


Fig. 52.

354. What peculiar arrangement within the ear? How are these bones arranged? How do they move with the vibrations of the tympanum? What substitute for a chain of bones do we find in birds and reptiles? How can this bone be seen in the ear of a bird? 355. How many cavities has the internal ear?

356. With what does the vestibule correspond? How is it separated from the middle ear? How is this partition perforated? How are these openings closed? 357. What are the semi-circular canals? In what animals are those canals found? What is their use? 358. From what does the cochlea derive its name? What is the form and position of the cochlea? To what class of animals is it peculiar? What has been supposed to be the use of the cochlea? 359. How are the cavities of the internal ear lined? What is distributed on this

membrane? With what are these cavities filled? What constitutes the real organ by which impressions of sound are received and transmitted? How are the vibrations of sound communicated to the nerve?

360. At what rate does sound travel through the air? What is its velocity through water? What advantage then is gained by the nerves receiving impressions through water instead of air? Why do animals which live in air require an apparatus more complicated than those which live in water? What parts do we find added in those animals which live in air?

What is said in regard to the adaptation of the tympanum and the bones which connect it to the internal ear to receive the vibrations of the air? 361. Will the faculty of hearing be entirely lost if the drum is destroyed? How will the hearing be affected by its loss?

362. How may the faculty of hearing be increased in acuteness? Upon what does this increase seem to depend? What examples are given of the habit of attention?

363. What is sight? 364. What is the organ of sight? In what does it consist essentially? 365. How do some of the inferior animals seem to be guided in their movements? 366. With what are most insects provided? Of what are those compound eyes made up? What is each facet? How numerous are these facets? How many in the eye of a butterfly?—in the beetle? What seems to be the use of

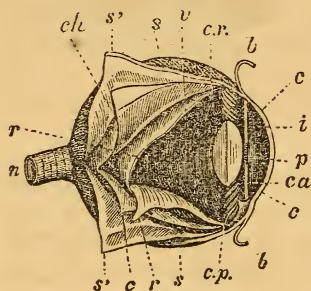


Fig. 53.

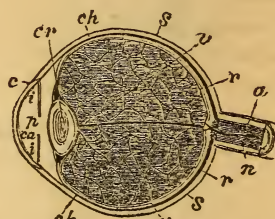


Fig. 54.

so large a number? 367. With how many eyes are spiders provided? 368. How many eyes are there in the snail, and how are they situated? How is the eye placed in crabs and lobsters? 369. How many eyes are there in all the higher animals? 370. What is the form of the eye, and how is it placed? How is the orbit lined?

What takes place when a person becomes very much emaciated? 371. How is the eye protected against insects, dust, &c.? 372. What

membrane is there in birds and reptiles? How is it drawn across the eye? How does it protect the eye without preventing sight? 373. With what is the horse provided? Describe the hawk. 374. How is the anterior surface of the eye covered? 375. How is the conjunctiva moistened? Where is the lachrymal gland situated? What is continually pouring out from this gland? How is this secretion increased? How do the tears pass out of the eye?

Where is the lachrymal sac situated, and how do the tears escape from it? 376. Of what are the walls of the eye composed? How is its interior occupied? 377. Describe the sclerotic. 378. Describe the cornea. How is it received into the sclerotic? What portion of the eye does it occupy? What is said in regard to its prominence at different periods of life and in different animals?

380. What fluid occupies the anterior chamber of the eye? How does it affect the form of the cornea? 381. Describe the vitreous humor. 382. The crystalline humor. What is the form of it? How is it suspended in its place? 383. How are the aqueous and vitreous humors separated from each other? From what does the iris receive its name? What opening has the iris in the centre? What is the form of the pupil in man?

How does it vary in size? 384. To what is the blackness of the pupil owing? What is the color of the pupil and iris in albinos? What peculiar appearance has the eye in many quadrupeds? 385. What is the form of the pupil in grazing animals?—in carnivorous animals? 386. What is situated inside of the choroid coat? Describe the retina. 387. How is the globe of the eye moved? How does the superior rectus move the eye?—the inferior rectus?—the internal rectus?—the external rectus?

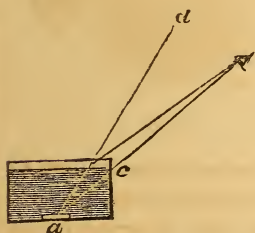


Fig. 55.



Fig. 56.

Describe the superior oblique. What is the use of this muscle? In what direction does the inferior oblique turn the eye? 388. To what do the coats and humors of the eye seem adapted? How does the eye compare with optical instruments? 389. How are the rays of light affected by

passing obliquely from a rarer to a denser medium? The refraction is in proportion to what? What examples are given, illustrating the refraction of the rays of light in passing from air to water?

390. How are the rays of light refracted towards the pupil? 391. How are the rays of light affected by the crystalline lens and the vitreous humor? What is the position of the image on the retina? Describe Fig. 58. 392. How may the inverted image be seen?

393. What is the use of the black pigment on the internal surface of the choroid? How does the light affect the eye in albinos? 394. How are short and long-sightedness caused? 395. What is the defect in short-sightedness? What is the form of the cornea in short-sightedness? 396. How is it frequently caused?

397. How may short-sightedness be remedied? What power do sailors acquire by the habit of viewing objects at a distance? What kind of glasses may be used to remedy short-sightedness? What will be the effect of using glasses that are too concave?—not quite concave enough to compensate for the convexity of the eye? How does the eye gradually return to its natural form? 398. What is the cause of long-sightedness? What change in the eye diminishes its convexity? How may the difficulty be remedied? 399. What is said in regard to the liability of the eye to become diseased? What parts are liable to become inflamed or to be injured by improper use? What causes induce disease? How may disease be prevented?

TOPICS FOR REVIEW.

How many senses are there? Which is the most universally diffused? What is its extent in man?—in insects?—in fishes?—in those animals covered with hair?—in most of the mammalia? With what is the true skin in man studded? Where is the sense of touch most acute? What is taste? What is its use? How is it excited? To what parts is it confined? What is the structure of the tongue in birds? To what use is the tongue applied by some birds? How are animals directed in the choice of their food? How is man guided? What sympathy exists between the stomach and the sense of taste? What is smell? How do bodies impart odorous particles? Where is the special seat of the sense of smell? What is the size of the nose in animals remarkable for acuteness of smell? Do all animals perceive the same odors equally well? In what do carnivorous animals excel?—in what herbivorous? What is said of the dog?—the deer, and the antelope? What is hearing? What is the special organ of hearing? What is the essential part of this organ? Describe the different parts of the ear—the external, the middle, and the internal. What animals are destitute of the external ear? What parts are found in those animals living in the water? What is supposed to be the use of the semi-circular canals?—of the cochlea? At what rate does sound travel through air?—through water? Why do animals which live in air require a more complicated apparatus for hearing than those living in water? How may the faculty of hearing be increased in acuteness? What is sight? What is the organ of sight? Describe the eyes of insects—of the snail. What is the form of the eye in man? How is the human eye protected in man?—in birds?—in the horse? How is the eye kept moist? Describe the lachrymal apparatus. Describe the coats of the eye—the humors. How is the globe of the eye moved? To what purpose are the coats and humors of the eye adapted? Explain Figs. 57, 58. What is short-sightedness? How is it remedied? What is long-sightedness? How may it be remedied?

ANIMAL MOTION.

400. What power is characteristic of all animals ? 401. What are the organs of voluntary motion ? 402. What do the bones constitute ?—what the muscles ? 404. What are the principal hard parts in animals ? What is the composition of shells ?—of crusts ?

405. In what state do bones exist at first ? How are they converted into bone ? 406. Which portion of the bones continues to increase and which to diminish to old age ? What proportion of the bones is animal matter in children ?—in adults ?—in old age ? 407. What is the condition of the bones in children ? To what injury are the bones most liable at this age ? 408. How are infants made bow-legged ? 409. At what age do the bones arrive at perfection ? What is the condition of the bones in old age ? To what injury are the bones of the aged liable ?

410. How can we separate the animal from the earthy portion of the bones ? 411. How the earthy portion ? 412. What is said of the bones of the higher animals ? 413. What is the form of the principal bones of the extremities ? Describe the shaft, and the extremities of a long bone. 414. How are the different bones of the body united to each other ? 415. How are the different bones of the cranium united together ?

How are the sutures formed ? What is said of their firmness at adult age ? 416. How are the bones forming joints bound together ? How is the end of each bone covered ? How is each joint inclosed ? What is the office of the synovial fluid ? 417. How is this fluid sometimes affected by an injury ? 418. How may the structure of a joint be seen ? 419. How many kinds of joints are there ? What is said of the hip-joint ? 420. What circumstance seems designed to prevent dislocation at the hip-joint ?

421. Of how many bones is the skeleton of man formed ? How is it divided ? What bones are included in the head ?—the trunk ?—the extremities ? 423. Of how many bones is the face formed ? 424. Describe the cranium. Its walls are made up of how many bones ? 425. On what principle is the cranium constructed ? How is a separation of the bones prevented ? 426. Of how many bones does the spinal column consist ? How are they divided ?

What change takes place with the five sacral vertebræ ? 427. What is said of the number of the cervical vertebræ in the mammalia ?—in birds ? How many cervical vertebræ has the crane and the swallow ?

429. What do the vertebræ form when united together? 430. What is gained by the division of the spinal column into so many separate pieces? 431. Of what does each vertebræ consist? 432. What is the form of the two surfaces of the body of the vertebræ? 433. What is the form in fishes and reptiles? What kind of a joint do they form?

434. How are the two surfaces separated in fishes? 435. How do fishes propel their bodies? For what purpose are fins used? What attitude is peculiar to man? 436. What is the form of the spine in man? What advantage is obtained by this form? How do the vertebræ in man differ from those of all other animals? What is said of the spinal processes in quadrupeds? 437. How many ribs are there in man? What are the attachments of the ribs?

How many of the cartilages are attached directly to the breast-bone? What are the five lower ribs called? 438. What is the form of the breast-bone in man?—in those animals which have need of great strength in the upper limbs? What is said of it in the turtle? 439. How many extremities are there in all the vertebrated animals? What is said of their construction? What illustrations are given? 441. Describe the scapula or shoulder-blade. How is it attached to the trunk? What advantages are derived from this kind of attachment?

442. What are the attachments of the clavicle? What is the use of this bone? In what animals is it strongest? In what animals weakest? How is it in birds?—in the lion, deer, &c.? 443. How is the arm supported? How many bones are there in the fore-arm, and what are they called? On which side is the radius?—the ulna? How are the radius and ulna connected to each other? How do these bones rotate on each other? In what condition are the radius and ulna in most quadrupeds? 444. How is the hand anatomically divided? Describe the carpus—the metacarpus—the phalanges.

How many phalanges are there in the thumb?—in the fingers? 445. How are the foot and ankle in quadrupeds made more solid than the wrist and hand in man? Are these parts found solid originally? How many phalanges are there in the deer?—in the horse? 446. How do the upper and lower extremities differ from each other? 447. How are the lower extremities connected with the spine? How is the thigh supported?

What is the form of the upper extremity?—of the lower extremity? 448. How many bones form the leg? What is their comparative size? Describe the tibia. 449. What bone in front of the knee-joint? What is its use? 450. Of how many portions is the foot composed, and



Fig. 59.



Fig. 60.

what are they called? How many bones in the tarsus?—the metatarsus? How many phalanges are there in the toes? What do the tarsus and metatarsus form? What advantages are derived from this form of the foot? 451. In animals which walk on all-fours, how is a jar prevented from extending to the body?

452. How are parts of the skeleton set in motion? 453. Of what is each muscle made up? What is the size of the primitive fibrils? With what is each fibre supplied? How is the muscular tissue excited to contraction? What change takes place in a muscle when it contracts? When is the muscle

enlarged most in diameter? 454. Upon what does the energy of the muscular contraction depend?

455. In what cases of great nervous excitement is this frequency observed? What example is given? 456. What other purpose do the bones serve besides affording attachment for the muscles? 457. How do most of the muscles act on the bones? What law of mechanics in regard to this? Explain Fig. 61. What force in the muscle will be required to raise one pound at the wrist?

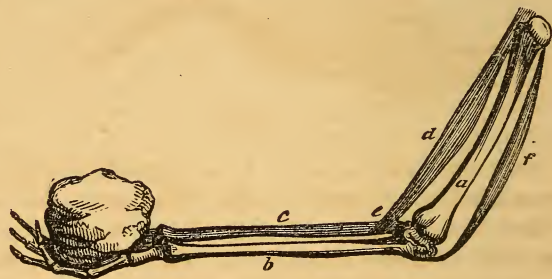


Fig. 61.

If this muscle contracts one inch, through what space will it move the wrist? 458. Under ordinary circumstances, upon what does the energy of muscular contraction depend? What kind of muscles act with greatest energy? What is said of the muscles in the sedentary and inactive? What is said of the arms of the smith, and the legs

of the pedestrian? What is said of the influence of exercise on the muscles, and on the health of all the powers?

459. How are the muscles affected by use? 460. In what animals is the energy of muscular contraction greatest in proportion to size? How far will a flea leap? How far would the same muscular power in man enable him to leap?

How much would it enable him to lift? What is said of some species of beetle? What is said of the movements of insects? 461. What are the various kinds of progression in animals called? 462. How is the body in fishes propelled through the water? How is the stroke made against the water in most cases? What propels the fish? How is the tail expanded in the whale, and how is its stroke made? What is said of the structure of the tail?—of the power of the whale?

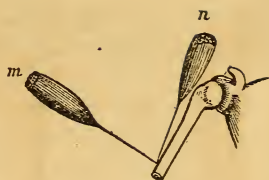


Fig. 62.

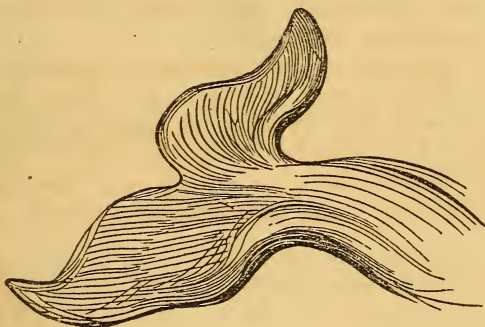


Fig. 63.

463. For what are the fins of fishes principally used? How is progression effected in serpents? 464. What other mode of progression is there in some serpents? 465. What does flying resemble? How are birds adapted to flying? In what respect do the bones of birds excel all other animals? What are the long bones? What does the breast-bone resemble?

What is gained by this peculiar form? How is the bony apparatus united together? What is said of the skeleton? How is the body suspended in the air? What is said of the muscles which are attached to the breast-bone?—to the back? In what direction is the greatest power of the wings? Describe the movements of the wings in the

effort to fly. 466. What is said of the rapidity of flight in birds? What examples? 467. How is walking produced? How is it pro-



Fig. 64.

duced in man?—in quadrupeds? 468. Describe running. What animal surpasses all others in running? 469. Describe trotting. 470. Describe leaping.

THE VOICE.

471. In what does the voice consist? 472. What animals may be said to be mute? Why may they be said to be mute? How do insects produce sounds? How is the chirp of the cricket produced? How is the sound of a grasshopper caused?—the mosquito?—bees and flies? How are other sounds caused? 473. How is sound produced in air-breathing vertebrata?

Where is it produced in reptiles? 474. How are the vocal organs situated in birds? What does the apparatus resemble? In what birds is it most complicated? 475. Where is the vocal organ situated in man, and what is it called? From what does it receive its peculiar form?

476. Which of the cartilages is the largest? Of what is it composed? What protuberance does it form? What is above and below the thyroid cartilage? 477. Where is the cricoid cartilage placed? What is its form? 478. What are the arytenoid cartilages? How are they placed? What do they resemble when joined together?

479. What are the vocal cords, and how are they situated? What is the form of the aperture between the vocal cords? How is it closed?

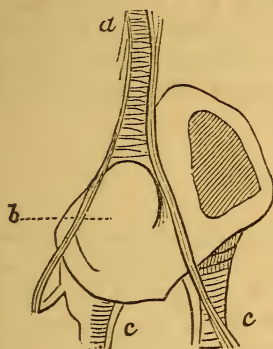


Fig. 65.

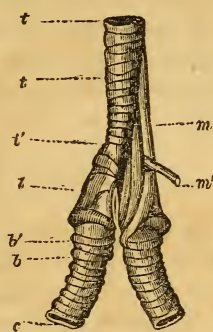


Fig. 66.

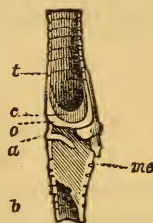


Fig. 67.

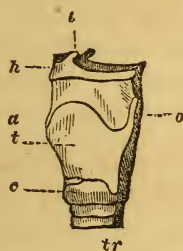


Fig. 68.

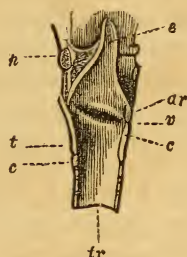


Fig. 69.

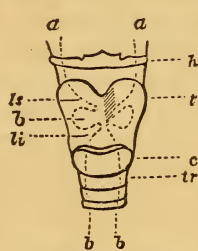


Fig. 70.

Of what other use is it besides to regulate the passage of air? What other guards has the larynx?

480. What is the condition of the aperture in the ordinary acts of inspiration, in the production of vocal sounds? What does the vibration of the vocal cords resemble? How are different sounds caused? What tone is produced when the tension is feeble?—when it is great?

481. How is the tension of the vocal cord regulated?

Have we any consciousness of the tension of the vocal cords? What

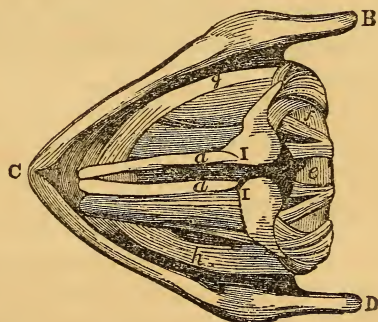


Fig. 71.

is their average length in the male in a state of repose?—in the greatest tension? What is the difference in the female? How many different degrees of tension are there in a natural voice? In a highly-cultivated voice? 482. How is loss of voice caused? What other parts are sometimes affected when the vocal cords are inflamed? 483. What is said of the power of producing articulate sounds? How may the voice be greatly improved?

THE HUMAN FORM.

484. What has always been given as one of the characteristics of man? 485. What is said of the importance of an erect form? What impression does a man of erect form make on us?—one of a stooping form? 486. What must be the effect upon health of any deformity of the cavities which contain the vital organs? 487. How are deformities usually caused? 488. What is the condition of the bones during childhood? How may the bone of the thigh be bent?

489. What are the most common deformities? What bones of the body are more easily changed in form than any other? Describe the ribs, and the manner they are attached to the spine and the breast-bone. How are the ribs affected by tight dress? How much pressure is necessary to produce deformity of the ribs? How may a young lady be deformed for life? How are the deformities of the spine caused? 490. Describe the spinal column. How is it maintained in the erect attitude? What takes place when the muscles become weakened? How does the deformity become permanent?

491. In what other way may curvature of the spine be caused? How does the habit of inclining to one side frequently commence? 492. With what kind of exercise should youth always be furnished? Is time for amusement sufficient? What parts should be exercised in amusement?

TOPICS FOR REVIEW.

WHAT power is characteristic of all animals? What are the organs of voluntary motion? What are the bones?—the muscles? What are the principal hard parts in animals? What is the condition of the bones when first formed?—in children?—in the aged? At what age do the bones reach their maturity? To what injuries are the bones most liable in children?—in the aged? How are the portions of the bones separated? What is the form of the principal bones of the extremities? How are the different bones united to each other?—the bones of the cranium and skull?—those forming joints? Describe the structure of the joints—the hip-joint. How many bones in the human skeleton? How are they divided? Describe the skull—the spinal column in man—in birds—in reptiles and fishes. What attitude is peculiar to man? Describe the ribs—the sternum. Describe Plate XIX. Describe the bones of the arm—the hand—the foot in quadrupeds—in man. What arrangement in quadrupeds prevents the jar from extending to the body? What are the muscles? On what does the energy of muscular contraction depend? How do the muscles act on the bones? Explain Fig. 61. How does exercise affect the muscles? In what animals is the energy of muscular contraction greatest? How is the body in fishes propelled through the water? How is the stroke of the whale made? How is progression effected in serpents? What is flying? How are birds adapted to flying? What is walking?—running?—trotting?—leaping? In what does the voice consist? What animals are said to be mute? How do insects produce sounds? How is sound produced in air-breathing animals? Describe the vocal organ in birds—in man. How is the tension of the vocal cords regulated? What is generally the cause of loss of voice? What is said of the power of producing articulate sounds?

QUESTIONS TO APPENDIX.

THE AIR WE BREATHE.

1. WHAT is the height of the air around the earth? What is its pressure on every square inch of the earth's surface? 2. What are the constituents of the air? 3. What is oxygen? When it combines rapidly with any substance, what does it produce? 4. What effect does it have on animals to breathe pure oxygen? How is man dependent on oxygen? How does it affect the blood? 5. How does oxygen affect the respiration and circulation?

6. For what is nitrogen useful? Does it support combustion or animal life? Why not?

7. What is carbonic acid? 8. What are the effects of breathing one per cent. of carbonic acid?—three or four?—six or seven? ten? How are persons affected who confine themselves in apartments containing only a small excess of carbonic acid? How does it increase the liability to consumption? 9. How is carbonic acid formed? What per cent. of the respired air is carbonic acid? How much per day? 10. How much carbonic acid escapes from the skin daily? What remarkable fact? 11. How much watery vapor is the respired air found to contain? Is this vapor pure water? What causes the fetid odor in the breath of some persons? What increases this odor?

12. What is said of the natural excretions of the skin?—of the amount of impurities which pass off from it? What is a general estimate of the amount of the daily excretions of an adult? What are the excretions composed of? What causes the peculiar odor of perspiration? 13. Give the total quantity of impurities which are daily given off by an adult. According to Dr. Lee, how much air does each person render unfit for respiration every minute?

VENTILATION.

14. What is said of ignorance in regard to ventilation? 15. What is the effect of breathing impure air? What is the condition of air which has been breathed over and over again in our parlors, school-rooms, &c.? 16. What is a common cause of typhus fever? Where do typhus fever, dysentery and the cholera take their origin? What is indicated by the countenance in the spring?

17. What heating apparatus was used till within the last half century? What is said of it? 18. What is said of an open fire as a ventilator? What objection to an open fire? 19. How does an open fire compare with an airtight stove? 20. What is said of hot-air furnaces and ventilating stoves? Is this system of heating perfect? Why not? 21. What is the temperature of air as it is delivered from most hot-air furnaces? How may this objection be obviated? 22. What method of ventilation is the best? 23. Repeat the rules for ventilation.

DIET.

30. How does man differ from other animals in regard to diet? How are other animals directed in the selection of food? How is man endowed? How should he select his food? 31. What circumstances should influence the choice of food? 32. How do the constituent elements of the body vary at different periods of life? What predominates in middle life?—in the child? What is the condition in the aged?

33. What dissimilarity exists in different individuals of the same age? To what should each person adapt his diet? 34. What do the inhabitants of cold climates require? On what do the inhabitants of tropical climates subsist? 35. What modification of food is required in temperate climates? What would be the effect of indulging in summer in a diet which might be appropriate in winter? What should each person possess? 36. In what proportion are different substances nutritious? From what source do animals derive the elements of their growth? On what does the nutritive value of different substances depend?

37. What is said of milk? 38. What elements does milk contain? 39. What is said of fish?—of salmon and eels, and of haddock, sole, flounder, cod and turbot? 40. How is the digestibility of fish diminished? When may a fish diet be employed? At what season of the year

is fish best adapted to the wants of the body? 41. What is said of oysters? 42. When are fish and oysters unsafe articles of diet? 43. What is said of lobsters?

44. What is said of meat? 45. Which are most digestible, young meats or old? 46. How does the vegetable kingdom compare with the animal in the number and variety of its aliments? What are the nutritive principles in vegetables? 47. What essential elements are to be found in abundance in vegetables? What examples of animals that live exclusively on animal—and on vegetable food? What variation in the digestive organs of the two classes? What is man in structure and habits? 48. What instances are given of an exclusive diet of each? 49. What is the universal preference of mankind?

50. What is said of ripe fruits? How are they regarded by most city physicians? Under what circumstances are fruits dangerous? Of what are the injurious results the consequence? 51. Under what circumstances may fruit and vegetables be regarded as safe? How are children affected by fruit? What caution should children observe? What is said of orange-peel, and the skins and stones of cherries, plums and grapes?—of cucumbers, beets, green potatoes, and green fruit?

52. Of what importance is water? What per cent. of the blood is water? What portion of the whole body is water? What purposes does water accomplish in the human body? 53. How does water compare with other drinks? 54. Has nature offered any substitute for water? 55. What is the effect of water on fires?

56. What substances are naturally difficult of digestion? What circumstances render the digestive process more easy? How does the flesh of young animals compare with others in digestibility? What circumstance facilitates digestion? 57. How does the art of cooking affect the digestibility of food? 58. What is said of boiling?—59. of roasting? 60. of frying? 61. of pastry?—of different articles compounded together? 63. How does the rapidity of digestion vary according to Dr. Beaumont? 64. What is said of variety of food? 65. Is a great variety at the same meal beneficial? 66. How is the diet of each individual to be determined?

THE TEETH.

65*. To what are good teeth indispensable? What is said of the matter which is constantly exuding from decayed teeth? What substances collect in the cavities of decayed teeth? 66*. Why do the teeth often

decay so early? 67. How does an accumulation of foreign substances between and around the teeth cause decay? 68. Does the natural use of the teeth cause their decay? 69. Where does decay usually commence? 70. What is the secret of preserving the teeth? 71. How may the teeth be kept clean? 72. What should be done when decay commences?

EXERCISE.

73. What is said of the importance of exercise?—of strength? What is ultimately the condition of those who live without exercise? 74. For what are the muscles designed? How does muscular action affect the blood, and the vital changes which take place in the growth and nutrition of the body? 75. What are the advantages which arise from exercise? 76. Why are the consequences of neglecting exercise not seen and felt immediately? What organ is most likely to become diseased first? 77. How can we secure the greatest benefit from exercise? What exercise will be found most useful? 78. Why should there be a variety of exercise? What will be the condition of the muscles that are not exercised? 79. What do we need besides exercise? How may the laborer or mechanic suffer?—How may the physician suffer? What do all persons require? 80. What is said of manual labor?—of field sports, games, &c.? 81. How is journeying most beneficial? 82. What is said of horseback riding? 83. What are gymnastic exercises? How are the muscles affected by this kind of exercise? 84. What is calisthenics? 85. How should gymnastic or calisthenic exercises be practised at first? What caution is to be observed after taking this kind of exercise? 86. What is said of walking?—How should walking be practised? 87. What are the advantages of collecting specimens for exercise? 88. When is the best time for taking exercise?

USE OF THE EYES.

89. What is said of the organ of vision? 90. For what special purpose is the eye formed? How is it adapted to viewing objects? What objection to long continued application of the eyes to small objects? 91. Why is artificial light more liable to prove injurious to the eyes than daylight?

92. In what rays is artificial light deficient? When are the eyes

most liable to be injured by artificial light? 93. What should be the position of the light? 94. At what hour are the eyes often injured? Why are the eyes more liable to be injured at this hour? 95. Why do the eyes require a short season of rest between daylight and dark? 96. What is said of weak eyes? How are weak eyes to be managed. Repeat rule first—second—third—fourth—fifth.

BATHING.

102. What is said of the antiquity of the practice of bathing? What ancient nations practised ablutions? How were the bathing establishments of the Romans constructed? How do the English and Americans of the present day compare with other nations in their habits of cleanliness? 103. What evils arise from habits of uncleanness? 104. Is ablution a necessity or a mere luxury that can be dispensed with? 105. What is said of the pleasure of bathing? 106. How was water regarded by the ancients? 107. How is water applied to the skin? 108. What is the temperature of a cold bath?—a tepid bath?—a warm bath? 109. How may a cold bath be applied? 110. What is said of the plunge bath?—of swimming? 111. What is a douche? 112. How may a shower bath be applied? What objection to shower baths as they are often constructed? What are the effects of the shower bath when properly managed? How should the shower be regulated? 113. Describe the effects of the cold bath. When there is not a healthy reaction, what are its effects? What persons are liable to be injured by cold bathing?

On what does the ability to practise cold bathing depend? How should the bather commence at first? 114. What are the effects of the tepid bath? 115. When is the best time for a cold bath? What objection to bathing after a full meal? 116. How long should a cold bath continue? 117. What are the effects of the warm bath? How does the hot bath act? 118. What is a water bath? 119. What is a transition bath? How is it practised in Russia? 120. When may a vapor bath be taken? 121. How is the frequency of bathing to be determined? How often should children be bathed?—persons in full health? What are the advantages of daily bathing?

CLOTHING.

122. What relation has the dress to the character of men? How do different persons dress? On what does our personal appearance

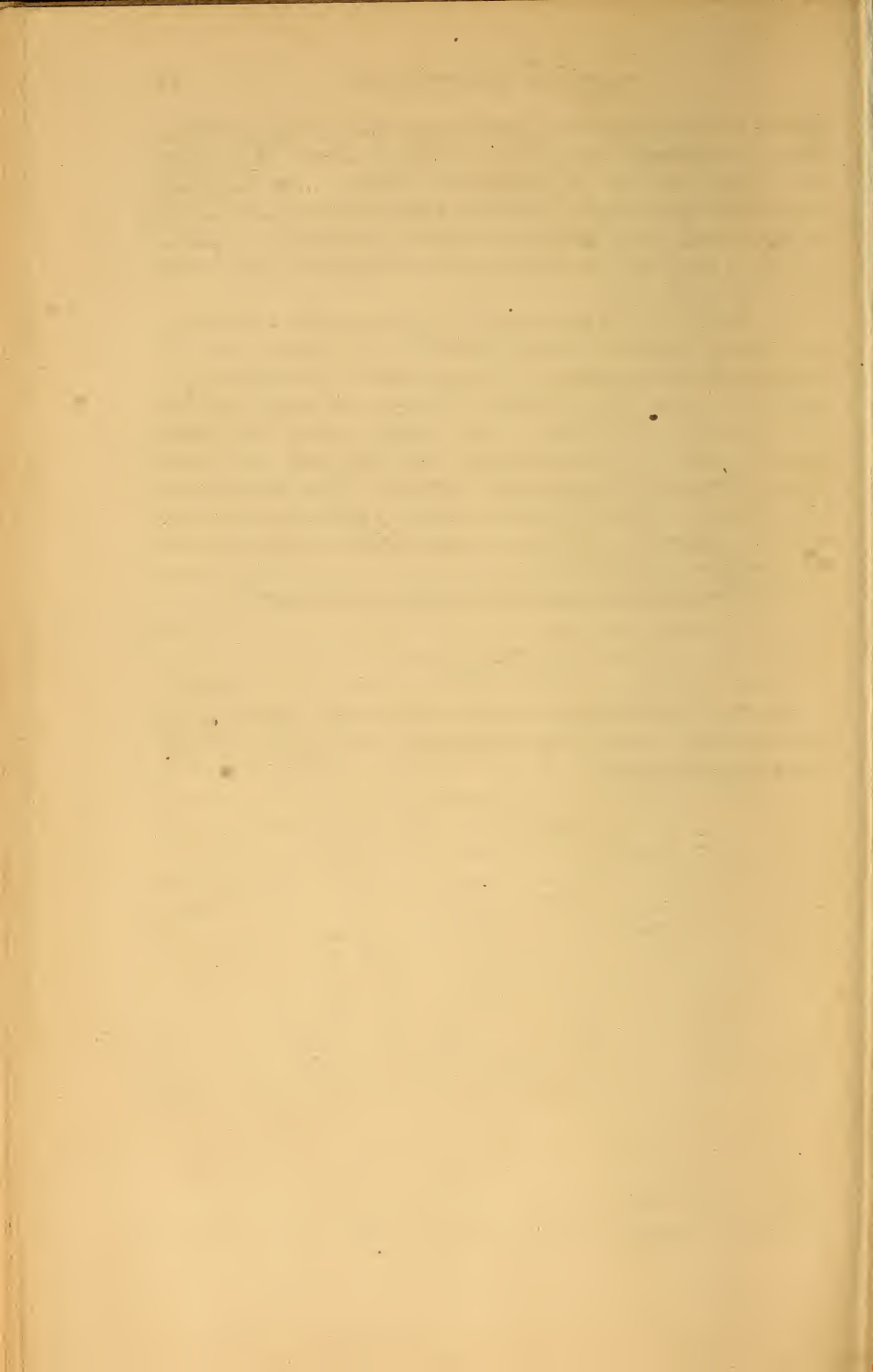
depend? What is the effect of indifference to the customs and habits of others in respect to dress? How is the fop esteemed? 123. What style of dress is most to be commended? What is more important than personal appearance? 124. What kind of clothing do we require during summer? 125. What is the object to be sought in winter clothing? 126. What is said of woollen?—of silk?—of fur? What objections to fur?

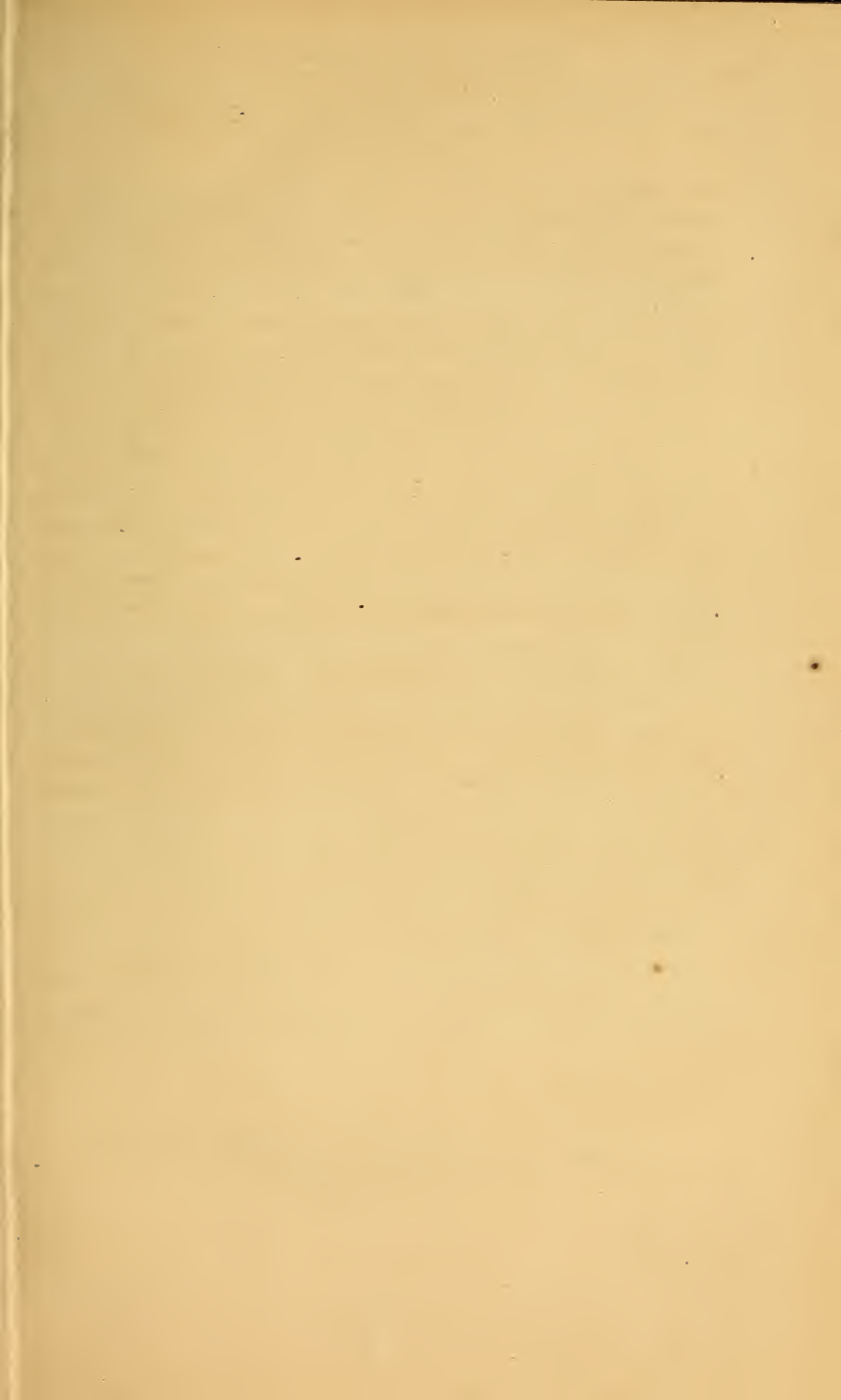
127. On what should the amount of clothing depend? 128. When is the greatest amount of clothing required? 129. On what other circumstances should the amount of clothing depend? 130. When is it necessary to put on extra clothing? What is said of the habit of "*bundling up*"? 131. What are the benefits derived from undergarments? 132. Of what importance is the form and size of garments? How should the garments be made? What objections to tight garments? 133. At what period of life is the folly of following fashion most apparent? What are the objections to dressing children with their arms and necks bare?

134. What organs are exposed by wearing low dresses?

BLEEDING.

135. How may bleeding be caused? 136. How may we know whether bleeding is from a vein or an artery? 137. How may arterial bleeding be arrested?







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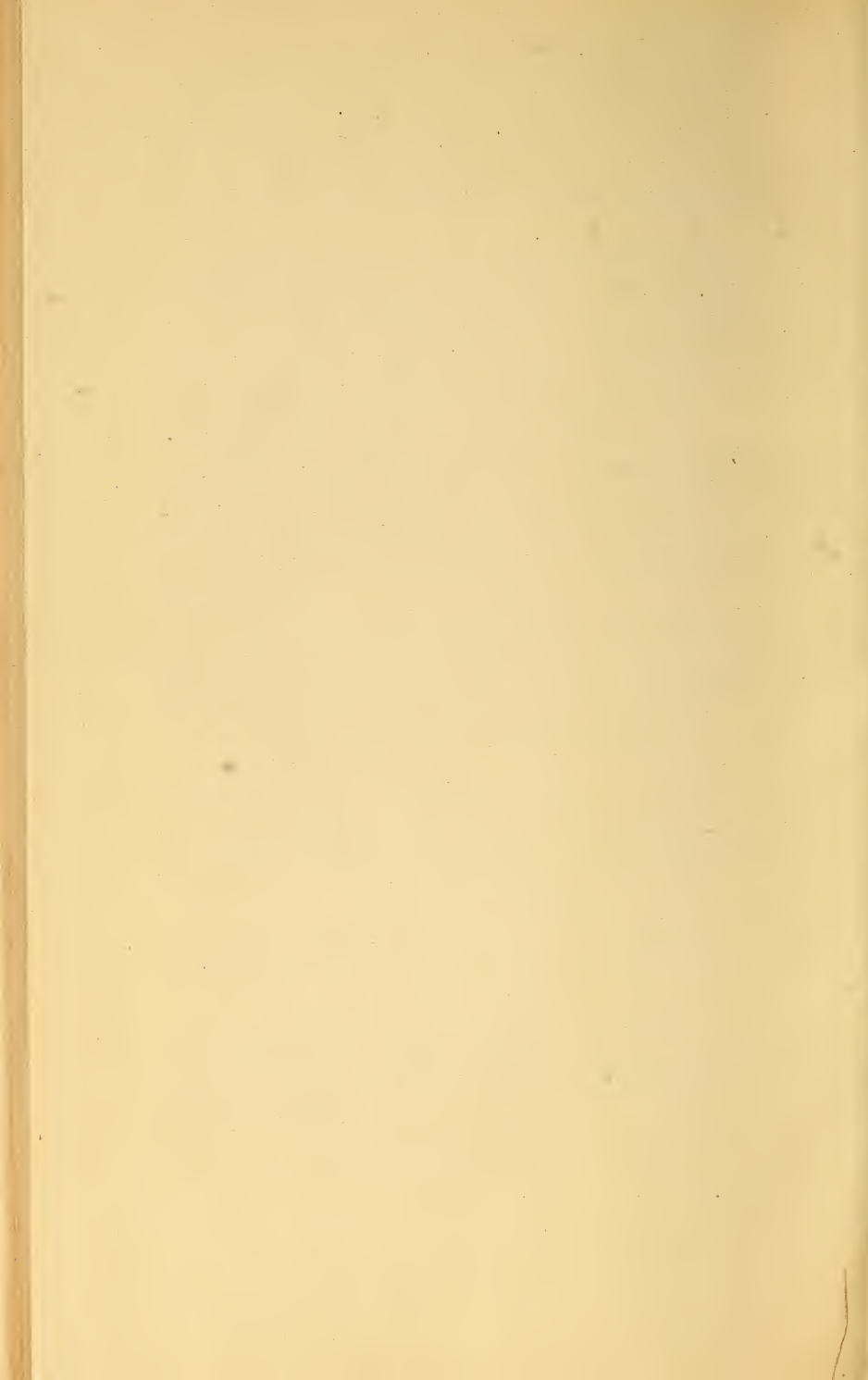
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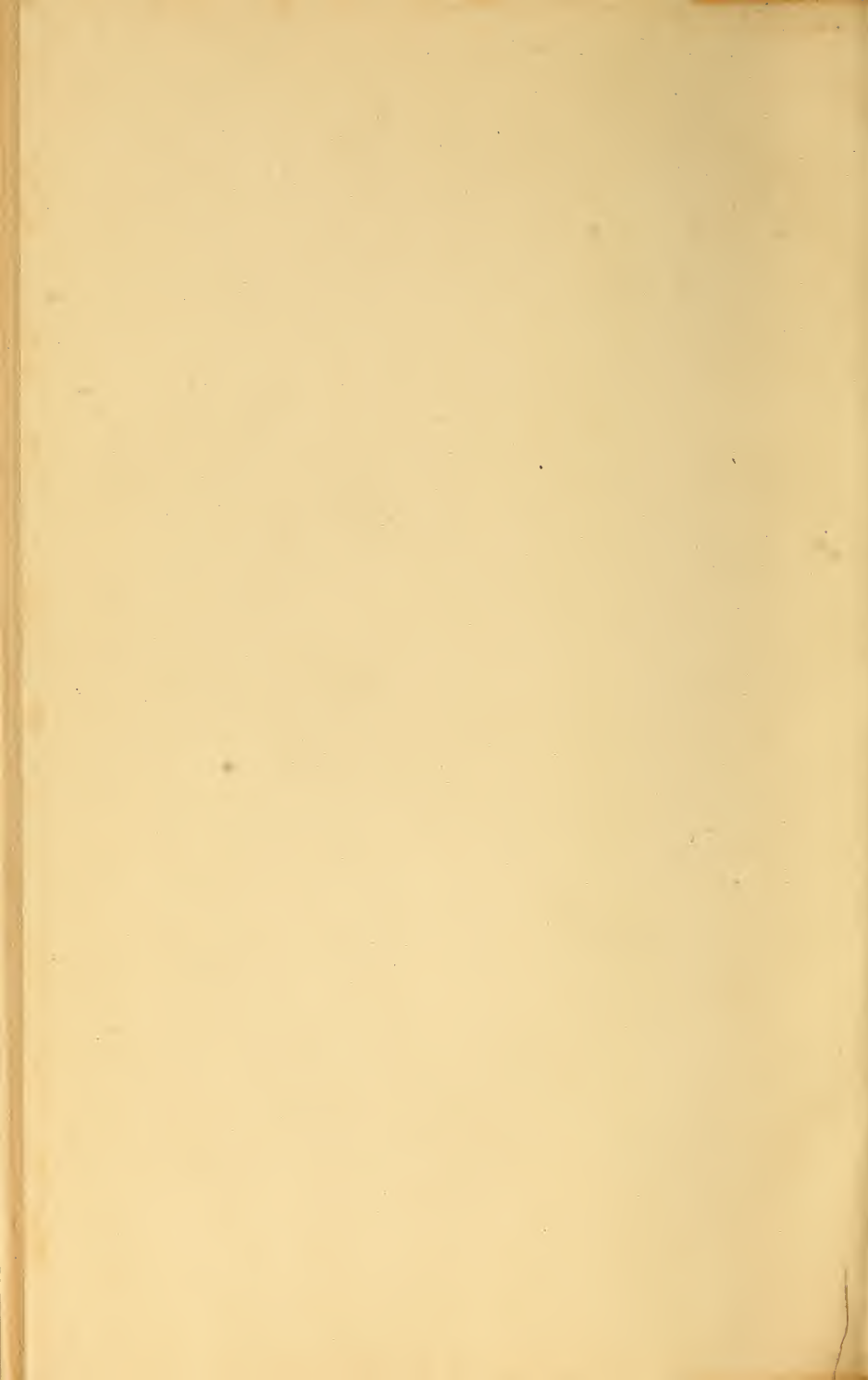
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